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## AIDS TO THE ART OF DRAWING.

THERE is no accomplishment which is of more genuine advantage than a fair knowledge of drawing. It is, in brief, a universal language which places its possessor in communication with the whole world; and while it is not needful that every man should be capable of producing effects which may be classified as finished works of art, the power of making a neat sketch, correctly proportioned, and also displaying an idea in a graphic manner so as to explain itself at a single glance, is an ability which cannot but be of the greatest value in the saving of both money and time.

As the majority of persons, however, are unable to handle the pencil with a sufficient degree of skill to depict their thoughts in a clear and comprehensive manner upon the blank paper, various ingenious mechanical aids have been contrived by means of which the draughtsman is enabled to reproduce a correct outline with comparative ease and rapidity. In the accompanying engravings will be found represented a variety of these devices depicted in the simplest and most practical form, with the view of affording the reader a guide for making his own apparatus from the commonest and most readily obtained materials.

### THE SKETCHING FRAME.

For those who wish to cultivate the eye, and thus learn to appreciate the difference of distances, without resorting to the more direct tracing of outline necessitated by many of the optical inventions described further on, the arrangement represented in Fig. 1 will be found of much assistance, and particularly in sketching from nature. In this branch of art the main difficulty lies in seeing too much, and hence, for instance, in an extended prospect there is a liability to crowd the paper with disproportionate details. Again, the eye naturally seeks for straight lines and boundaries to which to refer, and these absent, the mind is obliged to carry imaginary limits, a proceeding of no small difficulty to one not well practiced in so doing. The arrangement in Fig. 1 supplies a simple square frame, tightly hinged to the top of the ordinary lap drawing-board, so that it will stand in an upright position. Across this is stretched a number of threads or wires at equal distances apart so as to divide the interior space into small squares. The paper on the board is similarly divided by light pencil lines ruled over its surface. In making the sketch the artist draws so much of the view as he sees through one of his squares in the frame, into the corresponding ruled square on the paper, and thus having a large number of straight lines to refer to is very readily enabled to locate the details of the picture.

It is good practice, after employing the frame thus made for some time, to remove the wires and endeavor to sketch by referring simply to the edges of the former, and by thus progressing, it will be found that before long the apparatus can be entirely dispensed with, the eye becoming sufficiently educated to judge for itself.

Of course, the size of the squares ruled upon the paper governs the dimensions of the drawing, and it matters not how small they may be made so long as they correspond in number and relative position with those formed by the wires.

FIG. 1.—THE SKETCHING-FRAME.

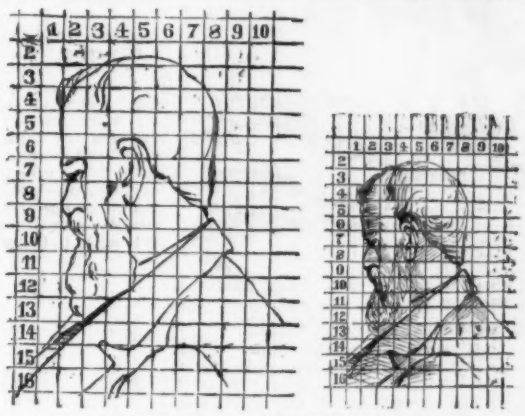


FIG. 2. REDUCING BY SQUARES. FIG. 3.

FIG. 4.—THE TRANSPARENT TRACING-TABLE.

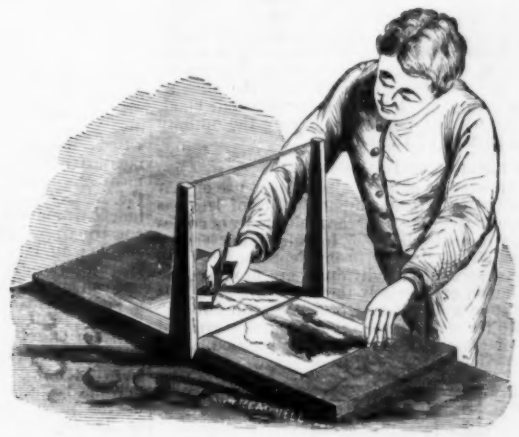


FIG. 5.—THE REFLECTING DRAWING-BOARD.

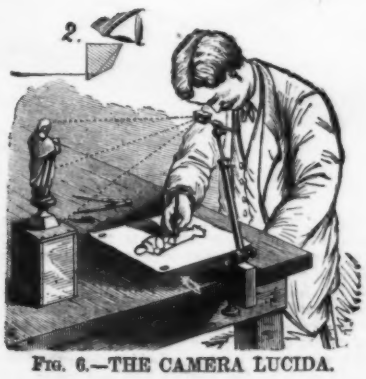


FIG. 6.—THE CAMERA LUCIDA.

FIG. 7.—THE CAMERA LUCIDA.

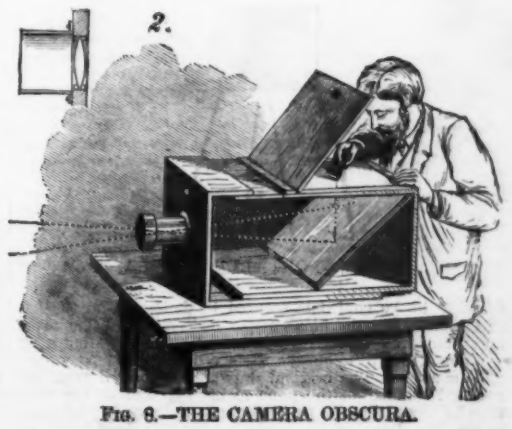


FIG. 8.—THE CAMERA OBSCURA.

AIDS TO THE ART OF DRAWING.

### COPYING, ENLARGING, OR REDUCING BY SQUARES.

This reduction of squares suggests a convenient mode of reducing or enlarging drawings already completed, which is represented in Figs. 2 and 3. Supposing Fig. 2 to be the original from which a smaller duplicate is to be made, a number of pencil-lines are lightly ruled over its surface at right angles, and the squares thus formed are for convenience numbered as represented. Then on the blank paper for the copy a similar number of squares are ruled in precisely the same manner, and correspondingly numbered. It is then very easy to fill in each square of the copy exactly so much of the drawing as is seen in the like square of the original. Thus in our figures, the eye in Fig. 2 is in square

FIG. 9.—THE FIELD CAMERA.

2-7, and in Fig. 3 it will be noticed that, though smaller, it occupies precisely the same place.

### THE TRANSPARENT TRACING-TABLE.

In copying fine pencil drawings, it would hardly do to rule other pencil lines over their surface, as the application of bread or rubber to remove the same would destroy the original. In such case, a neat arrangement of transparent tracing-table, as shown in Fig. 4, might be used. This consists of a square-bottomed box, the tops of the sides of which are inclined like those of a writing-desk. The back is open, and as the apparatus rests on the table, abuts against a window. The shade of the latter is drawn down to meet the upper part of the device, so that the light enters through the back of the latter, and the interior being lined with white paper, is reflected up through the inclined glass top. The original drawing might be secured above this glass, and a sheet of tissue-paper, ruled off in squares, placed above it. Being brilliantly illuminated from below, the drawing would readily show through and thus might be copied square by square, as above described. As represented in our engraving, however, the table is being used for direct tracing. Drawings on even thick antiquarian paper may be attached to the glass, and another sheet of the same material placed above, when still sufficient light will be transmitted to enable the lines underneath to be clearly seen and readily traced upon the upper sheet. The idea is precisely the same as is ordinarily carried out in holding a drawing and blank paper up against a window-pane, and tracing the outlines of one upon the surface of the other.

### THE REFLECTING DRAWING-BOARD.

The mention of window glass recalls another use of that valuable commodity for artistic purposes which of late has become quite popular, judging from the multiplicity of copies of the apparatus, represented in Fig. 5, for sale in almost every stationer's store. The device will bring Pepper's ghosts to mind, as these supernatural individuals are produced by an arrangement made on precisely the same principle. It is nothing more than a flat board provided with two uprights, both of which, with the board, are suitably grooved to hold a pane of glass in a perpendicular position. The

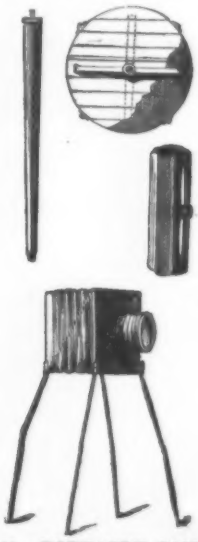


FIG. 10.—PORTABLE CAMERA.

drawing to be copied is secured to the board on the left of the glass and the blank paper on the right. The artist now stands as represented in our illustration—that is, so as to look down upon the surface of the glass at a very oblique angle. The original drawing is reflected from the polished surface of the pane to his eye, and at the same time he sees the white paper through the transparent glass, so that the lines of the model appear transferred, but reversed of course, upon the paper. These need only be followed with the pencil, and the outline is made. The apparatus is not of great use where reliable work is required, and indeed seems to us little more than a means of amusement. There are two reflections of the original thrown upon the eye, due to the rays striking both surfaces of the glass at unequal angles, which tend to confuse and render the outline indistinct. Again, unless the original be brilliantly illuminated, the shadow is so faint that the black lines of the pencil appear to blot out the finer details of the lighter portions. The glass must be, besides, accurately perpendicular, as otherwise a very distorted image is produced, and also be entirely free from defects due to imperfect annealing. The best kind to use, we think, is thin French plate, polished as highly as possible.

### THE CAMERA LUCIDA.

Probably the most really reliable optical device is the *camera lucida*, represented in Figs. 6 and 7, a simple arrangement extensively used by professional artists for saving time in sketching accurate outlines, of either the same dimensions as those of the originals, or enlarged or reduced. The principle of its construction will be readily understood from the small sketch marked 2 in Fig. 6. The glass is simply a four-sided prism, having one right angle, one of 135° and two of 67½°. When disposed as represented, the rays from the object pass into it without any appreciable refraction, and are totally reflected from the lower inclined side, and again from the upper inclined side, emerging near the summit in a direction almost perpendicular to the top face, so that the eye sees on the paper placed beneath an image of the object. If this image be traced by the pencil, a very correct outline, not reversed, is obtained. The use of this device requires some practice, as there is a difficulty in seeing both the image and the point of the pencil, for the latter really falls further from the eye than the position of the latter. This may be corrected by placing between the eye and the prism a lens which gives the rays from the pencil and those from the object the same divergence. It is, however, necessary to place the eye very near the edge of the prism, so that the aperture of the pupil is divided into two parts, one of which sees the image and the other the pencil. As will readily be understood, the nearer the object is brought to the prism the larger is its image, and the further away it is removed, the smaller the same, so that reduction or enlargement is thus easily made.

FIG. 11.

Fig. 6 shows the mode of placing the eye, and also the disposition of the apparatus, the construction of which will be understood from the larger view, Fig. 7. This last mentioned drawing has been made directly from the instrument constantly used by Mr. H. E. Mead, special artist of the SCIENTIFIC AMERICAN, and to that gentleman we are indebted for the explanation of an ingenious manner of constructing a device as represented from wood and other simple materials. The prism can be obtained at a small cost from any optician, and the rest of the apparatus any one can cut out of black walnut with a knife, and perhaps a gimlet or two. The thumbscrews used are of brass, of the kind employed for shutter-fastenings, and can be procured of any hardware dealer for a few cents each. B, in Fig. 7, is the prism, and A is a section of one of the joints, showing how the apparatus may be easily adjusted. A movable rod secured by a thumbscrew regulates the height of the prism, and the simple clamp shown secures it to the edge of the table. The entire arrangement thus constructed, we are informed, costs, exclusive of the prism, a little over one dollar.

### THE CAMERA OBSCURA.

One of the best known instruments, also based on optical principles, and which may be used in drawing, is the *camera obscura*, of which we have two forms. Fig. 8 is an arrangement adapted to taking views from windows or other fixed positions. It is a rectangular wooden box, formed of two parts, which slide in and out. The luminous rays pass into the box by a double convex lens secured in place as represented in section 2, and form an image on the opposite side, which is at the focal distance of the lens. But the rays are reflected from a glass mirror inclined at an angle of 45° and form an image on a piece of ground glass inserted above. When a piece of tracing-paper is laid on this screen, a drawing of the image is easily made. The wooden door shown serves to cut off extraneous light. The parts of the box slide one within the other, like the joints of a telescope, so that by elongating it more or less, the reflected image may be made to fall exactly on the screen, at whatever distance the object may be situated.

### THE PORTABLE FIELD CAMERA OBSCURA.

Fig. 9 is another arrangement of the camera obscura, in portable form, so as to be carried on sketching tours. The box or lantern portion, shown in detail in Fig. 10, consists in front and rear pieces of wood or tin, connected at the sides by cloth or paper, folded like the bellows of an accordion. In the front side is the lens, placed in a little telescope of tin, which easily slides in and out and inside of the back, and at its lower edge is hinged a small mirror, which, when the box is extended, falls forward until it strikes against a stop within the front side, which maintains it at an angle of 45°. Any convenient arrangement may be added to hold the box extended. When the latter is closed, the mirror folds against the back, the lens telescope slides in, and the front and rear sides come together, making a bundle little larger than a good-sized pocketbook. At each corner is a socket to receive the ends of bent iron wires, as shown, which serve as supports, and the lower extremities of which enter sockets attached to the sides of the table, as represented in Fig. 10. The table is composed of slats glued to a back of cloth. On the back of the middle slat is a socket, and also a bar pivoted in the middle, which turns as indicated by the dotted lines, and forms a solid support for the table when extended. The object of making the table thus in pieces is so that it can be rolled in a compact bundle. A tripod of legs jointed to a pivot which fits in the socket under the table supports the apparatus, and may, when detached, be folded into a single bar, serving as a walking-stick. A square of black cloth completes the device, and is thrown around the wires to form

FIG. 12.—THE PERSPECTIVE RULER.

a dark-chamber beneath the lens-box, large enough to accommodate the head and hand of the artist. The drawing-paper is attached to the table after it is extended and receives the image formed by the lens and reflected downward by the mirror.

### THE PROPORTIONAL DIVIDERS.

We have still to notice some ingenious devices which are more adapted as aids in mechanical drawing rather than as direct means of tracing outlines, as are the majority of the apparatus thus far described. Fig. 11 is termed the proportional compasses, and consists in two slotted arms of brass, German silver, or other metal, connected through the slots by a small sliding thumbscrew. Metallic points are provided at both ends of the arms. The object of the device is to reduce or enlarge drawings to a given scale, and for this purpose suitable divisions are marked on the edge of one of the slots. Suppose, for example, it be desired to reduce a given line to one third, the two long points are placed upon its extremities, a pointer on the clamping screw being previously removed to coincide with the ⅓ mark, so that the same forms the pivoting point of the two arms. The distance then included between the two short points at the opposite ends will be exactly one third the line measured, and hence may be thus laid off on the copy. In enlarging, the operation is reversed, and is too obvious to need explanation. The instrument can be made without difficulty by any one used to working in metals, and the marks on the arm can be obtained by actual experiment. It can be purchased, however, for a small sum from any mathematical-instrument maker.

### THE PERSPECTIVE RULER.

Fig. 12 is a simple arrangement for drawing lines in correct perspective, and avoids the difficulties happening when a vanishing point is marked at a considerable distance from the drawing, and the lines drawn therefrom by a long ruler. It consists in three arms of equal length pivoted together at one end by a screw-clamp. Two pins are inserted in the drawing-board, against which two arms of the "perspective lineal," as it is termed, abut. The angle of these arms and the position of the pins are governed by the distance required for the vanishing point, as the greater the angle the further the same is removed, and *vice versa*. Once adjusted, the parts are clamped firmly together, and the lines ruled by the upper side of the arm which rests upon the paper. Of course, the arms at an angle are always kept in contact with the pins, while the ruling arm, which is the lowest of the three, is moved up or down about the paper. This instrument is easily made of seasoned wood or metal. Two are necessary, right and left handed, owing to the construction, for use on each side of the board.

### THE PANTAGRAPH.

In concluding our series, we add an engraving of the pantagraph, Fig. 13, a quite useful instrument, in which the principle involved is that of the proportional compasses.

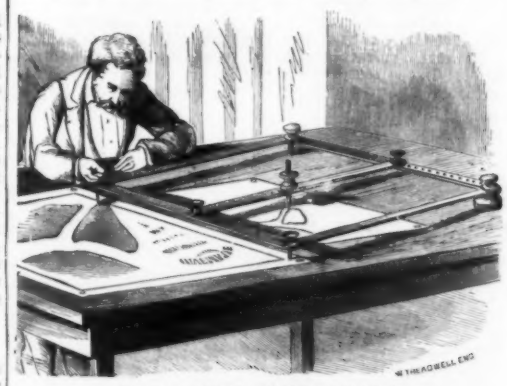


FIG. 13.—THE PANTAGRAPH.

There are four rulers, joined together at their intersections, and having at two of the angles supports terminating in round points or smoothly running casters. At one of the other angles is a weight to which the apparatus is pivoted, and which holds it in place, and at the fourth corner is a tracing-point, shown in the hand of the operator. Directly across the frame thus made, and pivoted at its ends to the centers of two of the bars, is a fifth ruler, through the middle of which passes a pencil. Along half the length of the two side-bars, and also of the central bar, are made perforations, so that the length of said rulers can be shortened as rendered necessary. The tracing-point is moved over the

outline to be followed, and its motion is communicated to the series of rulers which, by a kind of parallel movement, actuate the pencil to describe precisely the same line, equal in dimension to that of the copy, or enlarged or reduced. Space forbids our entering into the mathematical demonstration of how this instrument reduces or enlarges, but generally it may be stated that the scales of the two drawings are to each other as the distances of the pencil and of the tracing-point from the fulcrum or pivot of the pantagraph, and these distances are adjusted by altering the position of the joints in the holes above noted. Any good mechanic can make the instrument for himself from hard wood, though metal is better. Care must be taken in constructing the joints, as looseness or bad fitting in such places greatly impairs the accuracy of the copy. In fact, any of the devices we have described require but little skill, though perhaps some time and patience in their manufacture. But if properly finished in a workmanlike manner, none will fail to be handy and useful additions to any apprentice's collection of drawing-tools.

## AN IMPROVED CAMERA LUCIDA.

The accompanying figure represents an improved form of the camera lucida for the use of artists and draughtsmen. The different kinds of camera now in use, although they have all undergone various modifications, have nevertheless remained very inconvenient for those who have occasion to employ them, none of them allowing the image of the object and the point of the lead pencil to be seen at the same time with sufficient distinctness.

Desiring to remedy these defects, Dr. J. G. Hoffman, of Paris, has devised the present form of the apparatus.

Fig. 14 represents it, half size. The small outline is a transverse section of the optical portion, composed, at A, of a metallized mirror, or other highly polished and absolutely plane metallic surface; at B, of a small plane glass, forming, with the metallized mirror, a fixed angle. The object of the latter is to allow a portion of the luminous rays, coming

FIG. 14.—A NEW CAMERA LUCIDA.

from the object to be drawn, to pass, and at the same time to cause the point of the pencil to be seen alongside of the images projected on the paper. At G may be placed, at option, in a movable frame, either a plate with parallel faces or lenses of neutral glass of various foci. The object of the plane glass is to tone down the brightness of the sunlight when white paper is used. At C is the opening or eyehole to which the eye is applied. The button, D, serves to adjust the camera in a suitable position, a matter, however, which depends on the location of the artist with respect to the object; but generally the glass, B, is placed vertically. The same pieces of the optical portion of the apparatus have been made use of by the inventor in the construction of a modification to be applied to the microscope, for which, as well as for the telescope, all systems hitherto in use have given very indifferent results.

## HOW TO MAKE A CAMERA LUCIDA IN TEN MINUTES.

I first procured a pill box lid which just fitted on to the eyepiece of my microscope, and in the center of it made a circular aperture about the size of the top lens of the eyepiece. I then cut a piece of card to the shape of No. 2, Fig. 15, in which the angles, A E B and C F D, are both 45°, just nicked with a penknife along the lines, A E, B E, C F, and D F, and with a little gum affixed to the lid, as in No. 1. A

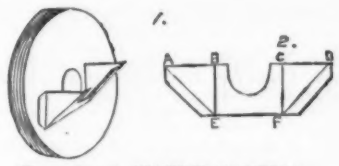



FIG. 15.—A SIMPLE CAMERA.

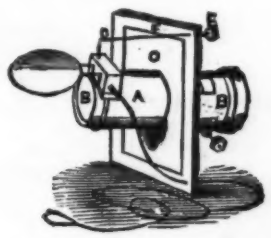
piece of thin covering glass attached to B E C F, and therefore inclined at an angle of 45°, completed the apparatus, which answered remarkably well.

## PNEUMATIC PHOTOGRAPHIC SHUTTER.

By W. BARRY.

I PRESUME that most of the photographic profession are using the above shutter to their cameras, and have little doubt but that they have found out ere this its weak point, viz., its being visible to the sitter, and thus causing them, when it is unexpectedly raised by an unseen power, and being a novelty also to them, to cast their eyes round to it, and especially children, who generally keep their eyes on it, expecting it to move again; and as we do not always want them looking straight to the front, we have devised the following scheme, so as to fix the shutter inside the camera, and so out of sight; thus the exposure can be made quite unobserved by the sitter. I can recommend it to all who have room inside their cameras to admit the shutter. In most double or C.D.V. or cabinet cameras there is just room—ours being of this description. Below is a sketch of the inside of the camera front, with the shutter attached as we use it.

A is a tin tube blacked, whose diameter is a quarter of an inch larger than the outside of the back tube of the lens, BB, to be used so that the lens will move freely in it, when moved by the action of the focusing screw. Length equivalent to the amount of lens tube inside the camera, when the lens is screwed or focused right in. C is a tin plate on which the tube is soldered, which is screwed to the inside of the camera front, leaving the sliding front free. On this tin tube the pneumatic shutter is fastened by the supplied means of the elastic band. It need not be fair on the top (as it always appears in the wood cuts), but to one side, if needed, as ours is, or even at the bottom; in fact, anywhere where there is most room for it; also so as to bring




the catch lever to fix the shutter up in a line with the most convenient place for the hole for the wire and button hereafter mentioned. The elastic tube to the air ball passes through a tight fitting hole (to prevent ingress of light) in front of the camera, and close to the bottom, so as to keep clear of the sliding front. The catch lever, to keep the shutter up when focusing, is fitted with a brass wire, D, terminating in a button, E, outside the front of the camera, through tight fitting hole, care also being taken to keep it clear off the sliding front. In the sketch it is shown as in our camera, viz., in the top right hand corner, also the hole for tube in the bottom right hand corner. There is a shoulder or rim, F, on the wire inside the camera, the distance between the shoulder and the button just leaving sufficient movement backward and forward for the release and catch of the shutter, about half an inch. It is obvious that the entire arrangement leaves the lens, BB, free to be moved (or focused) backward and forward to each extreme inside the tin tube, without carrying the shutter with it, or in any way interfering with it. The lens can even be screwed out of the flange, the sliding front removed and replaced by another front and lens, without disturbing the shutter at all; also, it in no way interferes with the shortening or lengthening of the camera.

We have found the plan to answer well, particularly with children or animals (the latter are sure to turn their heads to look at the shutter when it moves, if it is fixed outside); and if any of my photographic brethren feel disposed to give it a trial, I have no doubt they will be equally pleased with it.

I may add that we had to take the bellows arrangement out of its case, but it is easily done, and in no way detrimental to it; it is also protected from injury by its being inside the camera.—*Photographic News.*

## PHOTOGRAPHIC ENGRAVING.

By CAPT. J. WATERHOUSE, B.S.C.

OWING to the imperfection of photographic appliances in those early days of the art, the results obtained by Niepce could not have been very satisfactory, but with better appliances the same process has yielded in the hands of Niepce de St. Victor, the nephew of the inventor, Amand Durand, and others, results which prove its practicability, and its capabilities for reproducing images direct from nature, or for copying fine line engravings and similar subjects, for which latter it is much better adapted.

A process on this principle has been very successfully used at the Imperial State Printing Office, Berlin, for the engraving of plates for bank notes and other purposes, and I have also tried it myself with fair success.

The following outline will give an idea of the operations:

A perfectly smooth copper plate, having been thoroughly cleaned and polished, is coated with a solution of asphaltum in turpentine, to which a little oil of lemon is added. It is then carefully dried in the dark, so as to preserve an even coating, free from dust.

The image may be impressed upon the sensitive surface by sun-printing through an ordinary negative on glass, but as there is by this plan great risk of losing perfect sharpness by want of close contact between the glass and the copper plate, it is better to remove the collodion film from the negative, and transfer it on to the surface of the asphaltum, so that it may be in absolute contact with it all over, and thus secure the utmost possible sharpness of the image. The collodion film is loosened from the glass in an acid bath, containing one part each of sulphuric and acetic acids in 320 parts of water, and the transfer is then effected in a bath of one part glycerine and four parts of water. The transfer film being dry, the plate is ready to be exposed to light, and, as the asphaltum is not very sensitive, the exposure is somewhat long—extending from six to thirty-six hours; but it is better to over-expose and to work in diffused daylight, rather than in the full sunshine.

When the plate is judged to have been sufficiently exposed, the collodion film is removed, and the asphaltum surface is rubbed lightly with a tuft of cotton dipped in olive oil, to which, after a short time, a little turpentine is added. The image gradually begins to appear and by degrees the unaltered asphaltum is all removed, so that the design appears in clear brown upon the polished copper. The plate is then washed with soap and water, and allowed to dry.

The next operation is the etching or biting in of the image. The back of the plate having been well coated with a thick varnish of asphaltum, to protect it from the action of the acid, the plate is plunged into a trough containing a mixture of—

| | |
|---|---|
| Chlorate of potash | 1 part. |
| Muriatic acid | 10 parts. |
| Water | 48 " |

and allowed to remain till the weakest lines of the drawing begin to appear. It is then well washed, and the asphaltum covering the lines is removed with benzole. The design will now be seen standing in a slight relief, and an electrotype must be made in order to obtain a printing-plate, from which impressions may be taken in the ordinary way. The sharpness of the lines is better preserved by making a relief and electrotyping, than it would be by biting in.

The best results by this process are obtained from subjects in line, and even with these the operation of "biting in" demands a little manipulative skill. Good results have, however, been obtained in reproducing half-tone subjects, but they require the greatest skill on the part of the operator, and generally much retouching by a practised engraver.

A modification of Niepce's process, by which good results have been obtained, has been introduced by M. Négre. It is briefly as follows:

A plate of steel is covered with a coating of bitumen or bichromated gelatine, and exposed to light under a negative. After development by a suitable solvent, which removes the parts not acted on by light, the plate is placed in a solution of gold, and, by means of a galvanic battery, a thin regular coating of gold is deposited on those parts which present a clean metallic surface; the remainder of the sensitive coating is then removed, and a beautiful damascened design in gold is obtained. The gold adheres well to the metal surface, and, as it is not attacked by the etching liquid, the design may be etched without injuring the ground of the plate.

This process also appears only suitable for line work, though it is said that satisfactory results in half-tone have been obtained with it.

M. Baldus, of Paris, is said to have used a similar process, but to have etched his plates in a solution of sulphate of copper by attaching them to the positive pole of a galvanic battery.

The processes dependent on the use of asphaltum are all more or less slow and uncertain in practice, and if not already quite abandoned in favor of the quicker and more certain processes dependent on the use of gelatine and bichromate of potash, are rapidly becoming so, especially as their usefulness is almost entirely confined to reproducing subjects in line. Exceedingly fine results can, however, be produced in this manner, and it is particularly valuable in cases where an "etching" or "biting in" process is required, because the bitumen forms a much better "resist" for the acid or etching liquid than does gelatine.

## MILLERS AND THEIR MEN.

[*From Punch*].

(A civil-service examination in connection with the Board of Trade.)

EXAMINER—Now, sir, what is calico?

Candidate—Sir, there is theoretical calico and practical calico. Theoretical calico is a textile fabric manufactured from cotton—the laniferous envelope of the seeds of *Gossypium herbaceum*. That is rare. Practical calico is the more common thing.

Examiner—Indeed, sir! And how do you describe that?

Candidate—Practical calico, sir, the calico of commerce, and especially the calico designed for exportation, is formed in part only of cotton. It consists, besides, of size—a mixture composed of flour, China clay, Epsom salts, chlorate of zinc, chlorate of magnesia, and glue, in the proportion of from 70 or 80 to 130, and even 200 per cent.

Examiner—This information is new to us, sir. Will you oblige me with the origin?

Candidate—Certainly, sir. You will find the facts and figures I have had the honor to state in a recent issue of the Liverpool *Mercury*, quoted by the *Pall Mall Gazette*. They occur in the report of a law case—a suit between a cotton manufacturer and a firm of cotton warp-sizers, respecting a disputed charge for cotton warp-sizing. It is a distinct business—I had almost said branch of industry. The details I have given you were furnished by one of the plaintiffs, who coolly avowed his acts. In conclusion, he said he had been "in the trade twenty years, and in commencing only put 5 per cent. into the warps, and the size then consisted solely of flour, but now they had to add chemicals to get the weight up, as manufacturers asked them for more weight."

Examiner—Does any adage in an elementary educational work occur to you as applicable to that gentleman's career?

Candidate—*Nemo repente fuit turpissimus.*

Examiner—Very well, sir. In respect to composition, can you point to any analogy between cotton and silk?

Candidate—Silk proper, sir, is simply woven from the chrysalis-cocoon of the *Bombyx mori*. The silk you purchase is, much if not most of it, "loaded," as it is called, with logwood and gum. The web is sent to the dyer weighing, say, sixteen ounces. It is returned to the silk miller with its weight increased by from twenty-four up to forty ounces—the result of loading with matter in the wrong place.

Examiner—Can you name any other description of busi-

ness corresponding to that of cotton warp-sizers and silk-loaders?

Candidate—The business of stolen plate melters, or of sausage grinders who load their sausages up with a large percentage of carrion and cat's meat.

Examiner—What practical inference, sir, would you deduce from the existence of business and practices such as you have described?

Candidate—That in a country where adulteration constitutes a business of itself there is very much to account for the depression of trade; and that commodities formerly known as British "goods" are in the way to become notorious as British "bads."

Examiner—Can you suggest any means of limiting such objectionable operations as cotton warp-sizing and silk-loading?

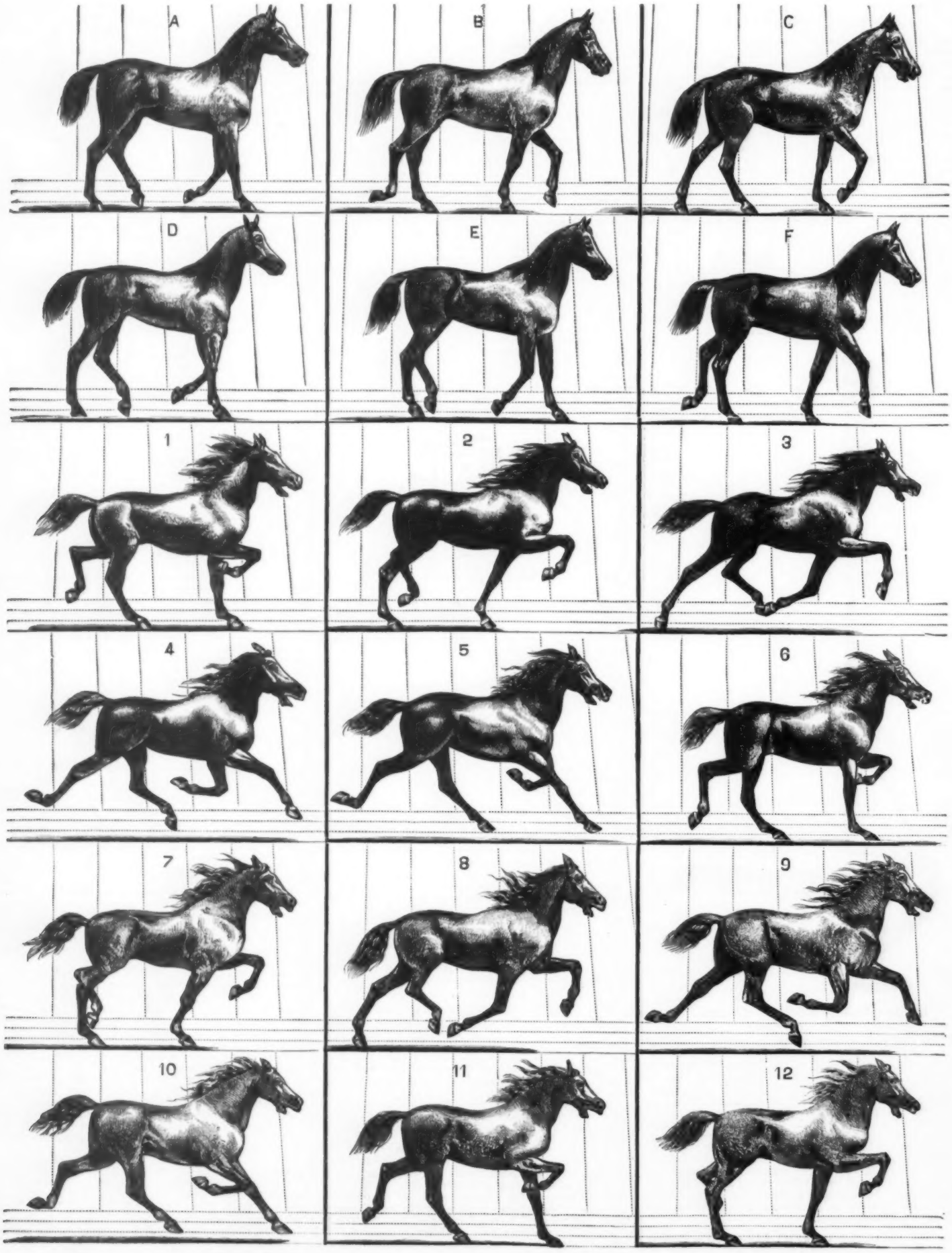
Candidate—Heavy fines and long terms of imprisonment with hard labor.

Examiner—That will do, sir. I have the pleasure to inform you that your answers have given me complete satisfaction.

## A HORSE'S MOTION SCIENTIFICALLY CONSIDERED.

A SHORT time since the SCIENTIFIC AMERICAN briefly noted the fact that Mr. Muybridge, of San Francisco, had perfected an automatic electro-photographic apparatus, by means of which he had succeeded in recording the action of horses in motion. Mr. Muybridge courteously responded by forwarding a series of instantaneous photographs, showing with absolute accuracy the motions of horses when walking, trotting, and running. From these we have selected two series, the first showing the movement of the horse "Abe Edgington," while walking at a 15 minute gait; the second showing the same horse while trotting at a 2:24 gait. These—omitting the driver and his sulky—we have had enlarged and skillfully engraved, as shown in the illustration on this page.

In taking the negatives of these photographs, Mr. Muybridge employed a series of cameras, operated by electricity and so placed as to fix with absolute accuracy the several phases in the continuous action of the horse while making one stride. The exposure for each negative was about the two thousandth part of a second. The vertical lines on the background are twenty-eight inches apart; the heavy horizontal line represents the level of the track; the others mark elevations of four, eight, and twelve inches respectively.




THE SCIENCE OF THE HORSE'S MOTIONS.—FIG. 1.

These lines are necessary for the analysis of the movements of the horse.

It will be seen that the walking horse always has two feet on the ground, and, for a brief interval in each stride, three feet. The positions of the feet shown in Figs. A and E indicate a stride of 4 feet 4 inches. When trotting at a 2:24 gait, the stride of the same horse is over 18 feet.

Figs. 1 to 12 show the latter motion. In Figs. 4 and 5, and again in 9 and 10, the horse is entirely off the ground, literally flying through the air. In his analysis of the stride, Mr. Muybridge notes that with this stride, moving at a 2:24 speed, the horse is entirely in the air about half the length of the stride, and for a brief interval he has one foot alone upon the ground. The relative time that a horse is on or off the ground is probably dependent upon his length of limb and stride, and rate of speed

The limit of our space forbids any attempt to follow the movements and positions of the four feet throughout the stride, further than to note that the figures from 1 to 6 depict half a stride, the remaining figures the other half.

The most careless observer of these figures will not fail to notice that the conventional figure of a trotting horse in motion does not appear in any of them, nor anything like it. Before these pictures were taken no artist would have dared to draw a horse as a horse really is when in motion, even if it had been possible for the unaided eye to detect his real attitude. At first sight an artist will say of many of the positions that there is absolutely no "motion" at all in them; yet after a little study the conventional idea gives way to truth, and every posture becomes instinct with a greater motive than the conventional figure of a trotting horse could possibly show. Mr. Muybridge's ingenious and successful efforts to catch and fix the fleeting attitudes of moving animals thus not only make a notable addition to our stock of positive knowledge, but must also effect a radical change in the art of depicting horses in motion. And every one interested in the physiology of animal action, not less than artists and horse-fanciers, will find the photographs of Mr. Muybridge indispensable.

Our drawings, though admirable and instructive as such, are necessarily inferior to the photographs in scope and variety of detail; and they lack also that element of indisputable accuracy which belongs to the sun pictures. However truthful, an artist's work cannot have the convincing force of a photograph. Six series of cards have been published, with from eight to twelve positions each, illustrating the single strides of trotting, cantering, running, and walking horses. They may be had of Muybridge, photographer, 417 Montgomery St., San Francisco, Cal.

We would suggest that for popular use the photographs should also be mounted on strips for use in the zoetrope. By such means it would be possible to see not only the successive positions of a trotting or running horse, but also the actual motions of the body and legs in passing through the different phases of the stride.

The following highly interesting and suggestive paper on some unsettled points in animal mechanics was read before the New York Academy of Sciences, at their regular meeting, November 4, by Prof. W. P. Trowbridge, of the Columbia College School of Mines.

The subject of animal mechanics is an important one; the very existence of animals depends on their power of locomotion, by which they are enabled to escape danger and to search for food. In recent times this subject has been studied by Marey, who instituted a number of ingenious experiments to determine the exact curve described by the wing of a bird while flying, and of a horse's hoof while in motion. Houghton studied the matter in a much more philosophical manner, and with the view to determine the laws of fatigue and rest. One of the most recent books on the subject, by Pettigrew, is so full of absurd and ridiculous positions, that its admission in the international series is a matter of astonishment. Huxley, in his physiology, briefly refers to the elementary machines as exemplified in the bodies of animals, and classes them as levers of the first, second, and third orders, while Marey assigns them all to the third order, and remarks that man has greatly improved on the model provided by his own body, as regards the transmission of power. A little consideration will soon teach us, however, that we are very far indeed from even approaching the perfection of our own structure in our best mechanical contrivances. Imagine a skeleton before us, all the bones of which may be provided with cords and pulleys, and then realize how far such a machine would be from uniting the infinite variety of motions executed by a lady while playing the piano; and yet all her motions are produced by the action of cords on rigid bones. Foucault compares the motions of a fish's tail with that of a propeller, but in reality there is no comparison between them. Man cannot approach the perfection of this animated instrument of propulsion.

To begin at the very foundation of our subject, in order to obtain a clear and connected view, the following forces may be considered as the only ones involved in animal locomotion:

External forces: 1, gravitation; 2, inertia; 3, friction.
Molecular forces.
Muscular contraction.

Of the nature of the force of gravitation we know nothing; but we all know its effects and the law according to which it acts, namely, "Every body attracts every other body directly as its mass and inversely as the square of the distance." With inertia we are all familiar. It is the resistance a body opposes to a force tending to move it. With friction we are acquainted chiefly as an obstruction to motion; but we are also continually availing ourselves of it to produce useful work. The difficulty of walking on ice will give us a faint idea of the predicament we should be in without the existence of this force. But for friction the mountains would run down and fill the plains.

Fig. 2

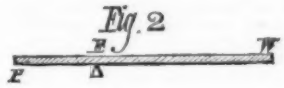
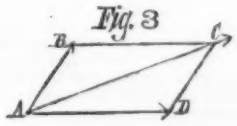



Fig. 3




Of the molecular forces, the only one we need consider is that which resists rupture from strains to which the animal frame is constantly subjected.

Muscular contraction is a vital force whose cause is not known; all we can say of it in this connection is that it pulls the tendons by which the muscles are attached to the animal frame.

All these forces are susceptible of being measured in pounds, and of being represented by right lines, the length of each line being in proportion to the amount of the corresponding force.

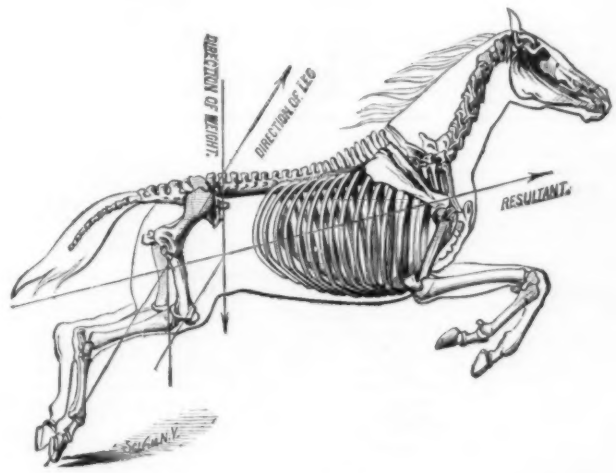



FIG. 4.—LEAPING.

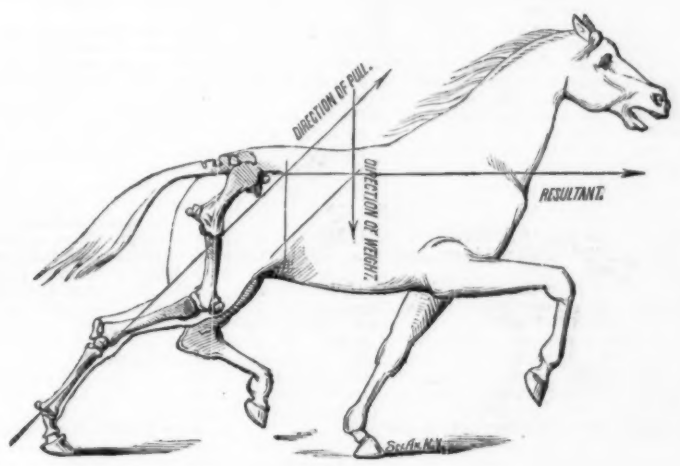



FIG. 5.—PULLING.

The dynamical laws involved in the motions produced in the animal mechanism by these forces are represented by the following axioms of Newton:

1. Inertness.
2. Motion is proportional to the impressed forces.
3. Action and reaction are equal.

By inertness Newton designates the force of continuance residing in matter by virtue of which it retains any force imparted to it. That the motion produced is proportional to the impressed force is an axiom to which we readily assent. The axiom that action and reaction are equal is involved in the fact that forces do not exist except in the action of one body upon another.

FIG. 6.

Only two geometrical theories are required to discuss the effect of forces on the animal mechanism. The first is that of the "moment of forces." The moment of a force is the product of that force, measured in pounds, etc., by the lever arm or perpendicular distance of its line of action from the fulcrum. Thus, in a common lever in equilibrium (Fig. 2), the power multiplied by its lever arm is equal to the weight multiplied by its lever arm, and the pressure on the fulcrum represents a third force, which maintains the equilibrium of the other two. The other theory involved is that of the parallelogram of forces. (See Fig. 3.) If one force, sufficient to move a body from A to B, acts simultaneously with another force tending to move the same body to D, the body will reach C by moving along the diagonal, A C, of the parallelogram constructed upon the lines representing the two forces.

All elementary machines, or simplest devices, by which force is applied to overcome resistance, either in mechanisms or the animal frame, may be classed under four heads:

1. Lever.
2. Inclined plane.
3. Jointed links.
4. Hydrostatic press.

The elementary machines have been discussed for many years, and authors differ greatly in their classifications; but the above may be the simplest for present purposes. The principle of the lever has already been stated, and it includes the wheel and axle and the movable pulley. The inclined plane and the jointed links (also known as the toggle joint) depend on the parallelogram of forces. A force applied at the joint of two rigid bars, one of which is fixed and the other free to move outward in such a way as to increase the angle between them, will be greatly multiplied at the free end. This machine is employed in hand printing presses, in Blake's stone crusher, in cutting iron, etc. The hydrostatic press depends on the distribution of pressure by liquids. (The Professor here exhibited a combination of all these machines in a single mechanism for stamping a die.) The mechanism of every machine, from a watch to a steam engine, and the frame of every animal, is made up of a combination of some of these elementary machines.

In the following remarks on locomotion, microscopic animals, which propel themselves by the vibration of cilia, or by simple contraction like the earthworm, are not considered.

A diagram was then shown, representing the skeleton of a tiger, to explain its great power of striking with its forefeet and of springing with its hind feet. A powerful muscle was seen attached to the backbone and to the forearm, and another to the shoulder blade and the projection of the elbow, thus forming a combination of levers producing the greatest economy of force. In the hind leg the muscles are similarly attached to a jointed link, having a great range of motion by reason of the ability of the animal to draw its hind legs close up to its body. Whenever the body of an animal is raised from the ground, it is done by means of jointed links, the ground furnishing the resistance.

The point was illustrated by a diagram of a horse in the act of leaping. (Fig. 4.) Here we have a thousand pounds leaping easily and readily into the air, and an examination of the hind leg of a horse will reveal the fact that it consists of a combination of jointed links. By the parallelogram of forces we then combine the force of propulsion with the weight of the animal, and we find the direction of the spring. When the momentary force of propulsion has ceased, gravity acts alone, and the horse reaches the ground by a curve. To resist the shock, the muscles of the foreleg are well developed.

It is generally supposed that horses draw loads by their shoulders, but this is an error. They do it chiefly by their hind legs, the trunk acting only as a beam, to which the traces are attached. (Fig. 5.) The resultant is here seen to pass through the trunk, and this explains why a horse pulling a load may at the same time carry a load on its back, the effect being to increase its own weight.

The force exerted in leaping was excellently illustrated by means of a jointed hat rack, where it was evident that very little force applied at one end propelled the other through a considerable distance.

The octopus uses the hydrostatic press alone to propel itself in the water. At first sight it would seem as though its long arms (30 to 40 feet), extending in all directions, would be extremely unfavorable to motion, but a little closer examination will show that it arranges them in the position of least resistance and swims backwards in the following manner: A powerful hollow muscle passing all around the animal's body is filled with water and confined by a valve, it is then forced through a narrow exit pipe, and the octopus moves by the force of the recoil.

The swimming of a fish is usually explained in the cyclopedias by means of a time-honored diagram representing a parallelogram of forces constructed on the resistance of the water and the motion of the fish's tail. It is very easy to understand how the tail moves the fish forward when it turns one way; but why the fish is not drawn back again by the contrary motion of the tail is not so plain. In fact, Sir John Lubbock at one time gave up the problem and confessed he did not see how a fish managed to swim.

It must be remembered that the tail of a fish is flexible, and that its flexure is in contrary directions during the two

halves of a stroke. The diagram (Fig. 6) will then make its action plain. Suppose the bent bar, *a b c*, to be articulated at *c* to a fixed piece, *c d*, and to move through a resisting medium from left to right. It is evident that it will exert a forward pressure at the point of articulation. Now, when it arrives at the extreme right, let the flexure of the bent bar be reversed, as shown in the dotted lines; we will have the same conditions as before, and a forward pressure will again be exerted upon the point of articulation, during the whole of the return stroke.

In the case of a fish's tail we have no bar, but a yielding material which will describe curves. An idea of this motion is easily acquired by waving a feather rapidly through the air. If the mainsail of a common schooner could by any mechanism be made to oscillate rapidly to and fro like the tail of a fish, it would propel the schooner. In the case of a snake wriggling through the water, the whole body may be viewed as a series of planes, each of which exerts the same forward pressure as does the tail of a fish. Some species of sharks propel themselves by a kind of sculling motion of the tail, which is so powerful that they have been known to jump clear over the decks of schooners.

Professor Trowbridge exhibited a small boat which he had constructed, and which was propelled in a trough by means of the fin of a fish oscillated by clockwork.

A great advantage of animal over artificial mechanism is that the animal frame adapts itself to the kind of work required of it; the muscles that come into play grow more and more capable of performing it. This point is well observed by comparing those whose labors affect one set of muscles chiefly with those accustomed to a great variety of motion—the hod carrier and the gymnast, for example.

The force of inertia is constantly experienced in every motion we make. We cannot even rise from a chair without leaning forward first, *i. e.*, placing our bodies in a position favorable for overcoming their inertia. In leaping, flying, etc., the initial effort is always the greatest, much less force being afterward required to keep up the motion. All these efforts result in fatigue proportional to their intensity. Thus, in walking on a level plane, the body is raised on an average 1·2 inch from the ground at every step. In walking up stairs the force expended is much greater. By the time a lady has ascended three flights of stairs, she experiences more fatigue than after walking around two blocks in New York. The study of animal mechanics may be productive of great advantage to us, by leading us to a better understanding of the laws of fatigue and rest.

Professor Trowbridge's paper was followed by a discussion in which Messrs Newberry, Warner, and Martin took part. Attention was drawn to the wonderful instinct by which birds so adjust the resisting surfaces of their bodies as to be able to sail across and even against powerful currents of air with apparent ease, and to another cause of superiority of animal over artificial mechanism, namely, the mysterious nerve communication by means of which the different organs transmit their sensations to the brain of the animal, and in return receive instantaneous commands, enabling them to adapt themselves to every emergency.

## THOMAS GRUBB, F.R.S.

AT the mature age of seventy-eight years, Mr. Thomas Grubb, F.R.S., died at his residence, Rathmines, Dublin, on September 19, last.

It is now over twenty-three years since Mr. Grubb appeared in a prominent manner before the photographic world. The late Mr. Sutton had written in advocacy of landscape lenses of small dimensions, which elicited a masterly rejoinder from Mr. Grubb, whose acumen as an optician was thereby immediately recognized. At this time Mr. Grubb was Honorary Secretary of the Dublin Photographic Society (of which he was the founder), as well as the editor of its journal, which was soon afterwards discontinued.

Several papers of the highest importance in photographic optics were afterwards published by Mr. Grubb, among these being the following:—On the Properties of Landscape Lenses; On Lunar Photography; On Some of the Optical Principles Involved in the Construction of Photographic Lenses; On a Screw Adjustment for Stereoscopic Lenses; On Proposed Standard Rules for the Dimensions of Lenses; On the Value of a Stop to a View Lens; On the Angular Field of a Lens; On the Effects Produced by Enlarging the Aperture of the Photographic Lens; On the Aplanatic Lens; On Comparative Trials of Photographic Lenses; On Lenses of Rock Crystal; On the Optical Center; On the Equivalent Focus of Photographic Lenses, and on the Angle of Subjects Included; On Displacement and Distortion; On Intensity and Quickness of Lenses; A Simple Method of Ascertaining the Equivalent Focus of a Photographic Compound; On the Equalization of the Photographic Image in Fields of Large Angle Projected upon a Flat Surface; and on the Relative Transparency to Actinic Rays of Glass and other Media.

These are the titles of the leading communications on optical subjects made to the public, either through the instrumentality of the photographic societies of London and Dublin, or of the *British Journal of Photography* and other channels. Such communications were not, however, exclusively confined to optical topics, for among other contributions to photographic literature, we find one—On a Large Sized Portable Camera and Stand for the Same, together with another, which we believe was the last he wrote, entitled—A Camera for Dry-Plate Work.

The invention of his "aplanatic" lens, in 1858, gave an impetus to the perfecting of landscape and group lenses; nor must we omit mentioning his services to the magic lantern by the invention, several years ago, of an achromatic condenser for that instrument, by means of which a wide angle of light may be condensed to a point sufficiently small to serve for illuminating a microscopic object. Mr. Grubb was also the inventor of the ingenious system of lens supports made use of by Lord Rosse in supporting his mirrors.

Notwithstanding Mr. Grubb's great talents as an optician, we do not know how far we can strictly speak of him as one by profession. It is quite true that he created what has since developed into very large and important optical works; but several years ago, owing to his genius as a mechanician, he received the appointment of Engineer to the Bank of Ireland, when the optical business he had created we had occasion to speak of only a few weeks ago, by whom the business has been exclusively conducted during the past ten years.

Originally intended for the mercantile profession, the mechanical tastes of the late Mr. Grubb were too strong to allow him to continue as he began; accordingly he threw himself with ardor into the higher departments of mechanics and optics, producing both refracting and reflecting astronomical telescopes of great magnitude and world-wide renown, the great Melbourne telescope being among the last executed under his own personal supervision. Mr. Grubb also invented and manufactured magnetic instruments which were supplied to more than forty British stations. When in Dublin, a few weeks ago, attending the meeting of the British Association, we, along with many others, were permitted to see in operation, at the Bank of Ireland, the wonderful machinery invented by Mr. Grubb for printing bank notes from steel plates, the machinery for engraving these plates and for renovating them when worn, together with the machine by which they are numbered, and which is of such an 'automatic nature as to resent any omission of routine duty on the part of the attendants by refusing to proceed with its work until all manual requirements have been complied with.

Of the optical establishment at Rathmines we shall say nothing at present, reserving our remarks for a subsequent article, in which we propose embodying some further notes we made during our recent visit to Ireland.

Mr. Grubb was a man of a singularly kind and unobtrusive disposition, and was much beloved by all who enjoyed the pleasure of his acquaintance. Although he had been confined to his bed for a considerable time previous to his death, he retained his intense love for mechanical pursuits to the very last. A swing bench had been devised and erected so as to turn over his bed, and here he had his vice and other tools. Often after working for hours would he be seen to have fallen asleep with the tools in his hand, as in the act of filing or adjusting some piece of mechanism. He died "in harness." Thus has passed away another of those veterans to whom photography has been so much indebted. —*British Journal of Photography.*

## THE ROYAL SOCIETY.

AT the recent annual meeting of the Royal Society, the business transacted consisted, as usual, of the election of council for the ensuing year, the presentation of medals, and the delivery of an address by the president. A special interest was attached to the address, as it was known that Sir Joseph Hooker had decided on relinquishing the presidency, to which he was elected five years ago. Toward the end of his address he alluded to his retirement, and stated that though wholly opposed to the view that the term of the presidency of the Royal Society should be either short or definitely limited, there were reasons, such as official duties at Kew, and the fear of accumulations of arrears of work in co-operation with other naturalists, which, in his particular case, made it almost imperative that he should resign his post.

The address was a retrospect of the progress in various branches of science during the last five years, and Sir Joseph said that during this time he recognized advances in scientific discovery and research at home and abroad far greater than any previous semi-decade could show. This estimate was explained as not referring to such inventions as the telephone, phonograph, and microphone, nor even to those outcomings of great research and high attainments—the harmonic analyzer of Sir W. Thomson, the radiometer and otheoscope of Crookes, or the bathometer and gravitation meter of Siemens—but to those discoveries and advances which appeal to the seeker of knowledge for its own sake, whether as developing principles, suggesting new fields of research, or awakening attention to hitherto unseen, or unrecognized, or unexplained phenomena of nature.

In the foremost rank as regards the magnitude of the undertakings and the combinations of means to carry them out was mentioned the Transit of Venus expedition, with which, Sir Joseph held, nothing in the history of physical science could compare. The value, he said, of the solar parallax could not be ascertained until the results of all the expeditions were taken into account, when it would have an international claim to acceptance; but he had received a communication from the Astronomer Royal which stated that the range appeared to be between 92,044,000 and 92,770,000 miles. After a reference to Janssen's photographs of the sun and Lockyer's discovery of carbon and oxygen in the sun, and his announced observations—not yet published—on the spectroscope studies, which have led him to believe in the indication of the breaking up of the molecules of bodies hitherto regarded as elementary, there were noticed in succession the investigation of electrical discharges by Müller, De la Rue, and Spottiswoode, and Tyndall's experiments on the acoustic properties of the atmosphere.

The essay of Count Gaston de Saporta, on L'Ancienne Végétation Polaire, was then referred to at some length, attention being especially drawn to the way in which the Count suggests a solution of the difficulty which has always presented itself—how to account for sufficient light within the Arctic regions for the rich flora which from fossil evidence it is known formerly flourished there. Saporta takes his facts from the work of Heer, though he differs from him in his inferences. Buffon, in his "Epoques de la Nature," had argued that the cooling of the globe having been a gradual process, the Polar regions must have been the first in which the heat was sufficiently moderate for life to have appeared upon it. Starting from this thesis, Saporta assumes that the termination of the azoic period coincided with a cooling of the water to the point at which the coagulation of albumen does not occur, and that then organic life appeared, not in contact with the atmosphere, but in the water itself. Not only does he regard life as originating, if not at the North Pole, at least near to it, but he holds that for a long period life was active and reproductive only there. Passing from speculations regarding the initial conditions of terrestrial life, the question, the president said, presented itself with regard to the carboniferous and later floras, how could plants have flourished in such latitudes if summers were of months and winters of similar lengths as now? Saporta suggested that besides the effects of probable fogs due to southerly warm oceanic currents, the solar light was, perhaps, not distributed over the globe as it now is, but was far more diffusive, the solar body not having arrived at its present state of condensation.

Sir Joseph pointed out that some of Saporta's conclusions were supported by the work of Mr. Thiselton Dyer, who, by a totally different line of research, had arrived at the conclusion that the northern hemisphere had always played the most important part in the evolution and distribution of new vegetable types, or, in other words, that a greater number of plants had migrated from north to south than in the reversed direction, and that all the great assemblages of plants which we called flora seemed to admit of being traced back at some time in their history to the northern hemisphere.

Turning to microscopical botany, a historical sketch was given of the origin and progress of the study of cells and cell division; Mr. Darwin's work on physiological botany was epitomized, and in the progress made in morphological botany especial reference was made to the work of Cohn, of Koch, and of Klein, on the development of spores within the rods of Bacillus. A practical result of these observations is that Klein has shown that typhoid fever of the pig is, like splenic fever, due to a Bacillus, and it is now distinctly proved that two diseases of the higher animals are generated by *contagium virum*. In presenting the medals the president gave a brief *résumé* of the work in recognition of which the medals were awarded. The Copley medal had been adjudged to Jean Baptiste Boussingault, a Royal medal to John Allan Broun, the Rumford medal to Alfred Cornu, and the Davy medal to Louis Cailletet and Raoul Pictet, this being a double award. Mr. W. Spottiswoode was elected president, and Mr. John Evans was elected to the office of treasurer, vacated by Mr. Spottiswoode. In the evening the usual dinner was held at Willis's Rooms, the new president occupying the chair.

## CEMENTS.

*Marine Glue.*—Caoutchouc, 1 oz.; genuine asphaltum, 2 ozs.; benzole or naphtha, q. s. The caoutchouc is first dissolved by digestion and occasional agitation, and the asphaltum is gradually added. The solution should have about the consistency of molasses.

*Cement for Paper Boats and for Mending Rubber Goods.*—Fuse together equal parts of pitch and gutta-percha, and to this add about 2 parts of linseed oil containing 5 parts of litharge. Continue the heat until the ingredients are uniformly commingled. Apply warm.

*Waterproof Cement.*—Shellac, 4 oz.; borax, 1 oz.; boil in a little water until dissolved, and concentrate by heat to a paste.

*Another.*—10 parts of carbon disulphide and one part of oil of turpentine are mixed, and as much gutta-percha is added as will readily dissolve.

*Rubber Cement.*—Digest caoutchouc, cut in fine shreds, with about 4 volumes of naphtha in a well covered vessel for several days. Naphtha should not be used indoors.

*Cement for Mending Hard Rubber.*—Fuse together equal parts of gutta-percha and genuine asphaltum; apply hot to the joint, closing the latter immediately with pressure.

*Chinese Cement.*—Shellac, dissolved in enough wood spirits (wood naphtha) to make a liquid of the consistence of molasses.

*Marine Glue, Much Used in Batteries.*—Dissolve 1 part of India-rubber in 12 parts of benzole, and to the solution add 20 parts of powdered shellac, heating the mixture cautiously over a fire. Apply with a brush.

*Siemens' Cement.*—12 lbs. black iron rust or iron filings, 100 lbs. sulphur.

*Muirhead's Cement.*—3 lbs. Portland cement, 3 lbs. rough sand, 4 lbs. smith's ashes, 4 lbs. resin.

*Black Cement.*—1 lb. rough sand, 1 lb. smith's ashes, 2 lbs. resin.

*Electrical Cement.*—Use the best sealing wax.

*Cement for Insulators.*—Sulphur, lead, plaster of Paris, with a little glue to prevent it setting quickly.

*Singer's Cement for Electrical Machines and Galvanic Troughs.*—Melt together 5 lbs. resin and 1 lb. beeswax, and stir in 1 lb. red ocher (highly dried and still warm), with 4 ozs. plaster of Paris, continuing the heat a little above 212°, and stirring constantly till all frothing ceases; or (for troughs): resin, 6 lbs.; dried red ocher, 1 lb.; calcined plaster of Paris, ½ lb.; linseed oil, ¼ lb.

*Cement for Coating Acid Troughs.*—Melt together 1 part pitch, 1 part resin, and 1 part plaster of Paris (perfectly dry).

*Cement for Chemical Glasses.*—Mix equal parts of wheat flour, finely-powdered Venice glass, pulverized chalk, and a small quantity of brick dust, finely ground; these ingredients, with a little scraped lint, are to be mixed and ground up with the white of eggs. It must then be spread on pieces of fine linen cloth, and applied to the crack of the glasses, and allowed to get thoroughly dry before the glasses are put to the fire.

*Pollack's Cement for Iron and Stone.*—Take litharge and red lead, equal parts; mix thoroughly and make into a paste with concentrated glycerine to the consistency of soft putty; fill the crack and smear a thin layer on both sides of the casting so as to completely cover the fracture. This layer can be rubbed off if necessary when nearly dry by an old knife or chisel. M. Pollack has used it to fasten the different parts of a fly-wheel with great success. This cement is fire and water proof.

*Cement for Closing Cracks in Stoves.*—This cement is prepared by mixing finely pulverized iron, such as can be procured at the druggist's, with liquid water glass to a thick paste, and then coating the cracks with it. The hotter the fire then becomes the more does the cement melt and combine with its metallic ingredients, and the more completely will the crack become closed.

*Aquarium Cement.*—Linseed oil, 3 ozs.; tar, 4 ozs.; resin, 1 lb.; melt together over a gentle fire. If too much oil is used the cement will run down the angles of the aquarium; to obviate this it should be tested before using by allowing a small quantity to cool under water; if not found sufficiently firm allow it to simmer longer or add more tar and resin. The cement should be poured in the corners of the aquarium while warm (not hot). This cement is pliable, and is not poisonous.

*Cement for Marine Aquaria.*—Take 10 parts, by measure, litharge; ten parts plaster of Paris, 10 parts dry white sand, 1 part finely powdered resin, and mix them when wanted for use into a pretty stiff putty with boiled linseed oil. This will stick to wood, stone, metal or glass, and hardens under water. It is, also, good for marine aquaria, as it resists the action of salt water. It is better not to use the tank until three days after it has been cemented.

*Coignet Béton.*—5 measures of sand, 1 measure of quicklime, ¼ to ½ measure of hydraulic cement.

*Waterproof Cement.*—Soak pure glue in water until it is soft, then dissolve it in the smallest possible amount of proof spirits by the aid of gentle heat. In 2 ozs. of this mixture dissolve 10 grains of gum ammoniacum, and, while still liquid, add ½ a drachm of mastic dissolved in 3 drachms of rectified spirits. Stir well, and for use keep the cement liquefied in a covered vessel over a hot-water bath.

*For Transparent Glue.*—Use the above, substituting isinglass for glue.

*Japanese Cement.*—Mix the best powdered rice with a little cold water, then gradually add boiling water until a proper consistence is acquired, being particularly careful to keep it well stirred all the time; lastly, it must be boiled for one minute in a clean saucepan or earthen pipkin. This glue is beautifully white and almost transparent, for which reason it is well adapted for fancy paper work, which requires a strong and colorless cement.

*Cement for Repairing Glass.*—Dissolve fine glue in strong acetic acid to form a thin paste.

*Bottle Wax.*—1. Resin, 6½ parts; beeswax, ½ part; Venetian red or red lead, 1½ lb. 2. Shellac, 3 parts; Venice turpentine, 1¼ part; vermilion, 2¾ parts, or Venetian or red lead, q. s. 3. Resin, 6 parts; shellac and Venice turpentine, each, 2 parts; coloring matter to suit.

*Cement for Metals, or Metals and Leather, Rubber, or Cloth.*—Fuse together equal parts of gutta-percha and pitch. Use hot.

*Glue to Fasten Leather, etc., to Metals.*—1 part crushed nut galls digested 6 hours with 8 parts distilled water and strained. Glue is macerated in its own weight of water for 24 hours, and then dissolved. The warm infusion of nut galls is spread on the leather; the glue solution upon the roughened surface of the warm metal; the moist leather is then pressed upon it and dried.

*Cement for Porcelain.*—Use thick white-lead paint.

*Simple and Useful Cement.*—Alum and plaster of Paris, well mixed in water and used in the liquid state, form a hard composition and also a useful cement.

*To Mend Crockery Ware.*—One of the strongest cements, and easiest applied for this purpose, is lime and the white of an egg. To use it, take a sufficient quantity of the egg to mend one article at a time, shave off a quantity of lime, and mix thoroughly. Apply quickly to the edges and place firmly together, when it will very soon become set and strong. Mix but a small quantity at once, as it hardens very soon so that it cannot be used. Calcined plaster of Paris would answer the same purpose as lime.

*Cement to Resist Petroleum.*—A cement peculiarly adapted to stand petroleum or any of its distillates is made by boiling 3 parts of resin with 1 of caustic soda, and 5 of water. This forms a resin soap, which is afterward mixed with half its weight of plaster of Paris, zinc white, white lead, or precipitated chalk. The plaster hardens in about forty minutes.

*Postage Stamp Mucilage.*—Gum dextrin, 2 parts; water, 5 parts; acetic acid, 1 part; dissolve by aid of heat and add 1 part of spirits of wine.

*Red Sealing Wax, Fine.*—Melt cautiously 4 ozs. pale shellac in a copper vessel, at the lowest possible temperature; add 1¼ oz. of Venice turpentine, previously warmed, and stir in 3 ozs. vermilion; pour into metallic moulds and allow it to cool.

*Red Sealing Wax, Common.*—Resin, 4 lbs.; shellac, 2 lbs.; melt; mix in 1½ lbs. Venice turpentine and red lead.

*Black Sealing Wax, Fine.*—Shellac, 60 parts; Venice turpentine, 20 parts; melt shellac carefully; add Venice turpentine; stir in 30 parts of finely-powdered ivory black.

*Black Sealing Wax, Common.*—Resin, 6 lbs.; shellac, 2 lbs.; melt; add 2 lbs. Venice turpentine, and lamp black to color.

*Gold Sealing Wax.*—Melt cautiously 4 ozs. pale shellac in a copper vessel, at the lowest possible temperature; add 1¼ oz. of Venice turpentine, previously warmed; and stir in 3 oz. mica spangles; pour into metallic moulds, and allow it to cool.

*Colored Sealing Wax.*—4 ozs. pale shellac, 1¼ oz. white resin, 2 ozs. Venice turpentine; add a finely-powdered pigment of the required color.

*Cement for Iron.*—The following cement is recommended for repairing damaged places in cast-iron tanks, cisterns, etc.: 5 parts brimstone, 2 parts black-lead, and 2 parts cast-iron filings (previously sifted) are melted together, taking care that the brimstone does not catch fire. The damaged place, perfectly dry, is well-heated by laying a piece of red-hot iron upon it, and is then stopped with the cement, previously heated in a melting-ladle till it becomes soft.—*Metall-Arbeiter.*

*An Insoluble Cement.*—A very valuable cement has been discovered by Mr. A. C. Fox, of which details are published in *Dingler's Polytechnisches Journal.* It consists of a chromium preparation and isinglass, and forms a solid cement, which is not only insoluble in hot and cold water, but even in steam, while neither acids nor alkalies have any action upon it. The chromium preparation and the isinglass or gelatin do not come into contact until the moment the cement is desired, and when applied to adhesive envelopes, for which the author holds it to be especially adapted, the one material is put on the envelope covered by the flap (and, therefore, not touched by the tongue), while the isinglass, dissolved in acetic acid, is applied under the flap. The chromium preparation is made by dissolving crystallized chromic acid in water. You take:

| | |
|---|---|
| Crystallized chromic acid | 2·5 grammes. |
| Water | 15 " |
| Ammonia | 15 " |

To this solution about 10 drops of sulphuric acid are added, and finally 30 grammes of sulphate of ammonia and 4 grammes of fine white paper. In the case of envelopes, this is applied to that portion lying under the flap, while a solution prepared by dissolving isinglass in dilute acetic acid (1 part acid to 7 parts water) is applied to the flap of the envelope. The latter is moistened, and then is pressed down upon the chromic preparation, when the two unite, forming, as we have said, a firm and insoluble cement.

## FIREPROOF PAPER AND INK FOR DOCUMENTS.

FIREPROOF paper may be made, according to the *Pharmaceutische Zeitung*, from a pulp consisting of one part of vegetable fiber, two parts of asbestos, $\frac{1}{16}$ part of borax, ¼ part of alum. The ink is made from 85 parts of graphite, 0·8 part of copal varnish, 7·5 parts of copperas, 30 parts of tincture of nutgalls, and a sufficient quantity of indigo carmine.

## REMOVAL OF STAINS AND GREASE SPOTS.

The following table gives, at a glance, the best means of cleansing all kinds of fabrics from any stain whatever:

| KIND OF STAIN. | FROM LINEN. | FROM COLORED GOODS. | | FROM SILKS. |
|---|---|---|---|---|
| | | COTTON. | WOOLEN. | |
| Sugar, glue, blood and albumen. | Simple washing with water. | | | |
| Grease. | Soapsuds, alkaline lyes. | Lukewarm soapsuds. | Soapsuds, ammonia. | Benzine, ether, ammonia, potash magnesia, chalk, yolk of egg. |
| Varnish and oil paints. | Turpentine, or benzine, and soap. | | | Benzine, ether, soap; rub carefully. |
| Stearine. | Very strong alcohol, 95°. | | | |
| Vegetable colors red wine, fruit, red ink. | Sulphur vapors; warm chlorine water. | Wash out with warm soapsuds or ammonia water. | | The same; rub gently and carefully. |
| Alizarine ink. | Tartaric acid; the older the stain the stronger the solution. | Dilute tartaric acid if the stuff will bear it. | | The same; with care. |
| Iron rust, and ink made of galls | Warm oxalic acid solution; dilute hydrochloric acid, then tin turnings. | Repeated washings with a solution of citric acid, if the colors will bear it. | The same; dilute hydrochloric acid if the wool is dyed naturally. | Nothing can be done; and all attempts only make it worse. |
| Lime, lye, or alkalies. | Simply wash with water. | Drop dilute nitric acid upon it. The stain previously moistened can be rubbed off with the finger. | | |
| Tannin, green nut-shells. | Javelle water; warm chlorine water; concentrated solution of tartaric acid. | Alternate washing with water and with more or less dilute chlorine water, according to the colors. | | |
| Coal-tar, wagon grease. | Soap, oil of turpentine, alternating with a stream of water. | Rub with lard, then soap it well. After a time wash alternately with water and turpentine. | | The same; but use benzine instead of turpentine, and the water must fall on it from some height. |
| Acids. | Red acid stains are destroyed by ammonia followed by thorough washing with water. Brown stains of nitric acid are permanent. | | | |

With the above table, a few simple chemicals, and a good deal of care and perseverance, any one may set up a chemical cleaning establishment. Great pains must be taken when ether and benzine are employed to avoid their taking fire, the vapor of which when mixed with air is highly explosive. An open bottle of ether will take fire at a distance of several feet from an open flame, as a heavy invisible vapor issues from the bottle; when the vapor reaches the flame of a lamp the whole mass of vapor takes fire. —*Muster Zeit.*

## ALUMINUM AT THE PARIS EXHIBITION.

ALTHOUGH discovered in 1827 already by Woehler, aluminum was only, in 1854, produced in larger quantity by Deville. At that time its lightness, malleability, its beautiful bluish-white color, and the fact that it is not stained, like silver, by sulphureted hydrogen, caused many to predict a great future to the aluminum industry. The only drawback seemed to be the expensiveness of the process by which it was obtained. This, it was hoped, could be overcome easily.

This hope was, however, not realized, and the price of aluminum is at present yet very high. Consequently, it was again dropped from the list of metals available for industrial purposes.

After the lapse of several years, attention having been again called to its superior fitness for making scales, weights, philosophical instruments, watches, several firms commenced to manufacture larger quantities of the metal, and at the Paris Exhibition, in 1867, aluminum, in shape of bars, foil, wire, as well as numerous ornaments and scientific instruments, was exhibited, and found universal favor.

Ten years have since elapsed, and the last Exhibition has shown that, even if the cost of aluminum is not materially reduced, it will, nevertheless, in the future be extensively used in the arts and industries. These are not, as in the Exhibition of 1867, exhibited by a few pioneers, intended to show what there could be done, but the exhibited articles were the production of a regularly established branch of industry.

France, however, seems to be the only country in which the manufacture of aluminum has been made to pay. A few firms, founded in England and Germany, have either closed up or manage barely to get along.

H. Merlé & Co. are the principal aluminum smelters in France, while the "Société Anonyme de l'Aluminum" are the largest producers of ornamental and other goods, and aluminum alloys. The former firm exhibits aluminum in

blocks, wire, sheets, and foil. The last-named society exposes a large variety of goods, from a thimble and penholder up to complete dinner sets of aluminum bronze and of the pure metal. The former seems to find more public favor than the latter, probably on account of the lower price and the beautiful gold color. Tablespoons of aluminum bronze cost from 10 to 13 francs apiece; teaspoons from 14 to 24 francs a dozen. Thimbles of pure aluminum cost 1·20 francs apiece. A variety of small articles woven from aluminum wire found much favor.

The Clermont Sons, Lemaire & Fischer, among other goods, exhibited telescopes, opera glasses, and other optical instruments, which were either made altogether of aluminum or in which the lenses were at least set in that metal. They are of elegant appearance and very light. Scales, made entirely or partially of aluminum, were exhibited by A. Collot. They weighed quantities up to 100 grammes, and were sensitive to weights as small as 0·1 milligramme. They cost each 2,000 francs.

Coined and stamped aluminum was also exhibited in form of beautiful medals. An English firm (Johnson, Mathey & Co.) exhibited coins made of an alloy consisting of 98 parts of aluminum and 2 parts of nickel. They are very light and hard, and would seem to be suitable to replace the silver in coins of lower value.

The elegant color and the high luster of the metal were most advantageously displayed at the Exhibition, and prove that aluminum is fully entitled to its place among the precious metals.

The price of aluminum varies from 130 to 170 francs per kilogramme, just according to whether it is in form of blocks, wire, or sheets. Aluminum bronze, containing 10 per cent. of the pure metal, costs from 14 to 18 francs per kilogramme. A very beautiful alloy of aluminum and silver is also extensively used, and ranks in price between the bronze and the pure metal.

## RECENT ARCTIC EXPLORATIONS.

NEWS has lately been received of the successful progress of Prof. Nordenskjöld's Arctic Expedition, concerning which we gave some particulars. The New York *Herald* gives a map and the following account:

Relying on the facts brought to light by various explorers Professor Nordenskjöld, a learned Swede, after diligent study of the log books and collection of the narrations of different Norwegian whale fishers and seal hunters, who, in pursuit of their daring vocation, had often closely neared, nay with their shallow craft even passed into the dreaded Kara Sea, came to the conclusion that at a certain season of the year the route pursued by his countrymen might be traversed also by larger ships. Nordenskjöld devoted himself heart and soul to the solution of the Arctic problem. He met in Mr. Oscar Dickson, a wealthy merchant of Göteborg, a generous patron, ready to assist him with funds for realization of his farsighted plans, fully approved of by him.

On the 8th of June, 1875, Nordenskjöld left Tromsöe in a rather small vessel. He made the journey from the North Cape to Nova Zembla in six days, undertook there explorations of the whole country between Matyushin Schar in the north and Yugor Straits in the south, and then crossed the Sea of Kara up to a considerably high latitude (75½ deg. north latitude) until he reached the Yenisei on the 15th of August. The members of the expedition here separated, Professor Nordenskjöld and his companions going up the river, while the other half of the party returned by sea, accomplishing the voyage to Hammerfest in the short space of only ten days.

In the following year Nordenskjöld undertook a second trip. He chartered the Ymer, a small steamer, freighted her with goods likely to find a ready sale in Siberia, and quitting Tromsöe on the 25th of July, 1876, passed the North Cape in forty-eight hours, and landed at the expiration of three more days at Nova Zembla. In twenty-four hours he crossed the Matyushin Schar, and, entering the Sea of Kara, perceived it covered with drifting ice. Steering cautiously for some time along the coast, he then continued northward, and was happy to see the ice disperse more and more as she neared the 72d degree north latitude. He safely reached the Yenisei on the 15th of August, and anchored the vessel in a secure bay, which he, in honor of his friend, called Dickson's Port. He afterward proceeded up the river, disposed of his cargo, shipped new goods, and after a stay of eighteen days, profited by in making scientific researches, returned home. Just seven weeks after his departure he was again at Hammerfest.

In his comments on the second voyage, Nordenskjöld, laying stress on the fact that the Ymer was the first steamer which had ever plowed through the Sea of Kara, affirmed, on his own observations and those of Russian explorers, that a navigable way might also be found between the Yenisei and Cape Cheljuskin during the month of September, and probably also the latter half of August. The enormous mass of fresh water pouring into the Arctic Ocean from the rivers Obi, Irtich, and Yenisei, which all rise in the steppes of Upper Asia, effects a gradual thawing of the ice along the coast until a small channel is formed, affording a passage for even large vessels. Nordenskjöld further asserts that the immense icebergs accumulated on the eastern coast of Nova Zembla completely disappear during the autumn in consequence of the influence of this constant efflux from the first mentioned three Siberian rivers. In proof of his statements he also refers to the stream of the La Plata, which, albeit its waters are not quite so abundant as those of the Upper Yenisei, are nevertheless perceptible 15,000 kilometers from its mouth, a distance three times as long as that from Dickson's Port to Cape Cheljuskin.

Encouraged by the grand results of his first two voyages, Nordenskjöld, who had found in Mr. Sibiriakoff, a rich Russian gentleman, as substantial a supporter as in Mr. Dickson, addressed himself besides to his government for assistance in equipping and sending out a new expedition, on a scale far more extensive than his previous private enterprises. His memorandum, submitted to the King of Sweden and Norway, and published under the title "Framstallningrörande, 1878, ars Ishafsfard," is highly important, and not only contains an explicit *resume* of his further plans, but gives a succinct history of all the attempts made for exploration of the vast sea bordering on the north of Asia and Europe. Not content with the issue of his previous voyages, Nordenskjöld wishes to set out in search of the northwestern passage from Europe through the Arctic Ocean to the Pacific by way of Behring Strait.

King Oscar, himself a sailor, took the greatest interest in Nordenskjöld's plan. He granted him a considerable subvention, and commissioned skilled naval officers and scholars well versed in the various branches of science connected with such undertakings, to accompany the learned and indefatigable professor. The expedition—the object of which was tersely explained by Nordenskjöld to consist in "making geographical, hydrographical, and physical researches in the Arctic Ocean beyond the Yenisei, and, if possible, as far as Behring Strait"—originally comprised the steamers Vega and Lena—the latter of which was equipped by Mr. Sibiriakoff. These steamers were afterward joined by the Frazer and Express, two smaller vessels, engaged by the same Russian gentlemen for commencement of maritime commerce with Siberia.

On the 4th of July, 1878, the Vega, most appropriately fitted out for a long voyage in Arctic regions, left Gothenburg, and, after meeting the Lena at Tromsöe, quitted the Norwegian coast July 25. The Yugor Straits were passed on the 1st of August. Six days sufficed to traverse the whole Sea of Kara from Nova Zembla to the mouth of the Yenisei. On August 6 the Vega anchored at Dickson's Port, where the mail, with long reports on the course of the journey already accomplished, was posted. Only a stay of three days was made at this station, for on the 9th of August, as may be seen from the letters on hand, the Vega and Lena steered northward.

After a lapse of nearly two months a telegraphic message reached Mr. Sibiriakoff at Moscow on the 14th of October, announcing the safe arrival of his vessel, the Lena, at Yakutsk. These tidings, evoking quite a sensation in scientific circles, as they announced the unmolested passage around the north cape of Asia of the Lena, were a few days later confirmed by a dispatch from Captain Palander, the commander of the Vega, and Professor Nordenskjöld himself, proclaiming that after a cruise around Cape Cheljuskin the mouth of the Lena was reached, without any great obstacle from the ice, on August 27, and that full hopes were entertained of an auspicious continuation of the voyage to Behring Strait.

Even if Nordenskjöld and his party be prevented from passing through Behring Strait, such wonders have been already achieved by them as to make their names forever famous in the annals of Arctic explorations. Considering that the greater part of the Arctic Ocean from the Lena to Behring Strait has been already explored, the possibility of a northwestern passage is in fact established by Nordenskjöld's successful voyage from Nova Zembla to the Lena.

### THE SWEDISH NORTH-EAST PASSAGE EXPEDITION.

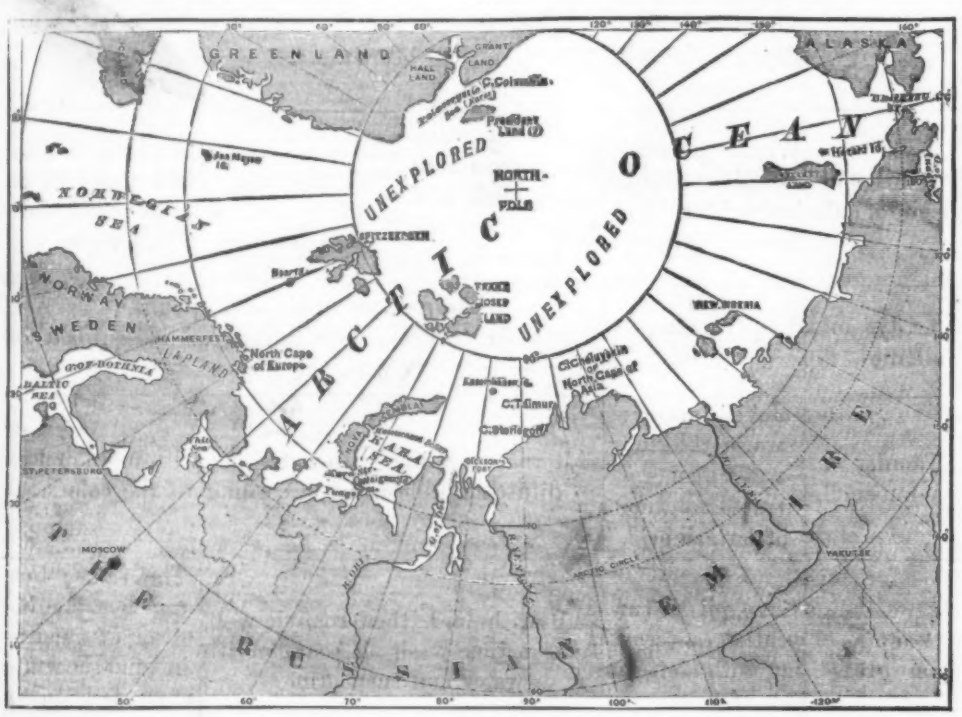
From letters dispatched from the mouth of the Lena by Prof. Nordenskjöld, on August 27, which have just been published in the Gothenburg *Handels Tidning*, we learn that the Vega accompanied by the Lena left Dickson Harbor, at the mouth of the Yenisei, on August 10, the weather being fine. On the 11th ice was seen, but it consisted almost exclusively of bay ice which did not obstruct navigation, which, however, was rendered difficult by a thick fog. The salinity of the water began gradually to increase and its temperature to fall. Organic life at the bottom grew richer at the same time, so that Dr. Stuxberg on the night between August 13 and 14, while the vessel lay anchored to a drift-ice floe, collected with the swab a large number of beautiful pure marine types; for example, large specimens of the remarkable crinoid, *Alecto eschrichtii*, numerous asterids (*Asterias linckii* and *panopla*), pycnogonids, etc. The dredgings near the land now too began to yield to Dr. Kjellman several large marine algæ. On the other hand the higher plant and animal life on land was still so poor that the coast here forms a complete desert in comparison with the rocky shores of Spitzbergen or West Nova Zembla. Auks, rotges, loons, and terns, which are met with on Spitzbergen in thousands upon thousands, are here almost completely absent. Gulls and *Lestris* which there fill the air with continual sound occur here only sparingly, each with two species, and it appears as if they quarreled less with one another. Only the snow-bunting, six or seven species of waders, and a few varieties of geese are found on land in any great numbers. If we add a ptarmigan or two, a snowy owl, and a species of falcon, we have enumerated the whole bird fauna of the region, at least so far as the Swedish expedition have been able to ascertain it. Of warm-blooded animals in the neighboring sea, only two walruses and some seals, *Phoca barbata* and *hispida*, were met with. There is probably great abundance of fish. Cosmic dust was sought for on the ice without success, but there was found upon it some yellow specks which, on examination, were found to be a coarse-grained sand, consisting exclusively of very beautifully-formed crystals up to two millimeters in diameter. The nature of these crystals was not ascertained, but it was evident that they are not formed of any ordinary terrestrial mineral, but possibly of some substance crystallized out of the sea-water during the severe cold of winter.

The Vega lay at anchor from August 14 to 18 in a harbor named Actinia Harbor, from the number of these animals brought up by the dredge from the sea-bottom. This harbor is situated in a sound between Taimyr Island and the mainland. The land was free of snow, and covered with a grayish-green turf formed of a close mixture of grasses, mosses, and lichens, forming a reindeer pasture much superior to that of the valleys in Spitzbergen which abound in reindeer. Only a few reindeer, however, were seen here, probably owing to the presence of wolves. The number of phanerogamous plants is exceedingly small; the moss and especially the lichen vegetation, on the other hand, abundant enough. Actinia Harbor is an excellent position for a meteorological station. The fog still continuing, the Vega and Lena sailed again on the 18th, and reached Cape Cheljuskin on the 19th, anchoring in a little bay which indents the low promontory, dividing it into two parts. The western point was found to be situated in 77° 36′ 37″ N. L., and 103° 25¼′ E. from Greenwich, and the eastern in 77° 41′ N. L., and 104° 1′ E. L. Inland the mountains appeared to rise by degrees to a height of 1,000 feet. These mountains, as well as the plains, were free of snow. Only here and there were to be seen large white patches of snow in hollows on the mountain sides or in some small depression on the plains. At the beach, however, the ice-foot still remained at most places.

The soil of the plains is clayey, partly bare, and cracked into more or less regular hexagonal figures, partly covered by a turf of grass, mosses, and lichens resembling that at the last landing-place. The rock here, however, was not granite, but upright unfossiliferous schistose strata rich in crystals of sulphide of iron, and crossed at the extremity of the cape by thick quartz veins. Dr. Kjellman could not find here more than twenty-four species of phanerogamous plants, most of them distinguished by a disposition to form compact half-globular tufts. The lichen vegetation was also, according to Dr. Almquist, monotonous, though luxuriantly developed. It almost appeared as if the plants of the Cheljuskin peninsula had attempted to wander farther toward the north, but halted when they met the sea, at the very outermost point. For here were found within a very limited space nearly all the plants, both phanerogams and cryptogams, which the land had to offer, and many of them were sought for in vain farther up on the plains.

Animal life on land rivaled the higher plant life in poverty. Of birds there were seen only a number of *Phalaropus*, some species of *Tringa*, a *Colymbus arcticus*, a very numerous flock of *Anser bernicla*, a few eiders, and the remains of a snowy owl. In the neighboring sea, which was almost free of ice, were seen a single walrus, two shoals of white whales and some few seals (*Phoca hispida*). It, too, was here evidently very poor in warm-blooded animals. On the other hand the dredge brought up from the sea-bottom various large algæ (*Laminaria agardhi*, etc.), and a large number of lower animals, among them very large specimens of *Idothea entomon*, an isopod, which also occurs in the Baltic and the large Swedish lakes, and is looked upon as an evidence that during the ice age they were connected with the Polar Sea. The algæ obtained were interesting as affording further proof of the incorrectness of the view which long prevailed, that the Siberian Polar Sea was quite devoid of the higher algæ.

On August 20 the voyage was resumed, the course being set east by south, in the hope of falling in with a continuation of the new Siberian Islands. Drift-ice was soon met with, and by the morning of the 23d it was found impossible to proceed further in that direction. An attempt was now made by sailing in a northerly and north-westerly direction to get out of the ice-field, and in about twenty-four hours the Vega was again in open water, and the same day land was sighted. The land was found to be the north-eastern extremity of the eastern Taimyr Peninsula, lying in about 76° 30′ N. L., and about 113° E. of Greenwich. The sea was completely free of ice for a distance of 15′ or 16′. Fine




## FROM HAMMERFEST TO BEHRING STRAIT.

MAP OF THE NORTHERN COASTS OF EUROPE AND ASIA, SHOWING THE NAVIGABLE ROUTE, FROM NORWAY TO JAPAN, DISCOVERED BY PROFESSOR NORDENSKJOLD.

mountains 2,000 to 3,000 feet high were seen some distance inland. These, like the plains below, were free of snow to their highest summits. Some small glaciers were believed to be seen, but they ended at a height of about 800 to 1,000 feet above the sea.

Animal life now began to be very abundant. Dr. Stuxberg had, while the vessel lay anchored to a floe in the drift-ice-field, brought up from a depth of 35 fathoms an unexpected variety of fine marine animal types, among them three specimens of a crinoid supported on a stalk, probably young individuals of *Alecto eschrichtii*, which also was found in innumerable full-grown specimens, masses of asterids (for instance *Solaster papposus, endeca, furcifer, Pteraster militaris, Asterophyton cucnemis*), and of the otherwise exceedingly rare *Molpadia borealis*, a colossal pycnogonid of 180 millimeters diameter, etc. Not less abundant was the lower animal life at a small depth, though the forms were partly different. The animals occurring here were evidently pure Polar Sea types without any immigration whatever from southern seas, such as has doubtless taken place in the case of the fauna of Spitzbergen.

On August 24 land was sighted, which was found to be Preobraschenski Island, near the mouth of the river Katanga. From this point to the mouth of the Lena the depth was only from 5 to 8 fathoms.

To judge from the experience of the voyage there is no more ice on the Siberian coast during the latter part of summer than in the White Sea during midsummer. Besides the ordinary observations of the temperature of the sea-water at the surface in connection with the common meteorological observations made six times in the twenty-four hours, the temperature and salinity of the water at different depths were determined two or three times a day. When the depth amounts to at least 30 meters the temperature at the bottom is found to vary between — 1·0° and — 1·4° C. The specific gravity of the water amounts there to 1·026—1·027, the salinity being little less than that of the water of the Atlantic Ocean. On the surface the temperature is exceedingly variable:—At Dickson Harbor + 10°, a little south of Taimyr Sound + 5·4°, among the drift ice off that sound + 0·8°, off Taimyr Bay + 3·0°, at Cape Cheljuskin + 0·1°, off Katanga Bay + 4·0°, between Katanga and Lena + 1·2° to + 5·8°. The specific gravity of the surface-water in a broad channel along the coast never exceeded 1·023, in general only amounted to 1·01 or under. The latter figure corresponds to a mixture of about one part sea water with two parts river water. This shows indisputably that a warm surface current of little salinity from the mouths of the Obi and the Yenisei runs first along the coast towards the north-east, and then under the influence of the rotation of the earth in an easterly direction. Other similar currents originate from the Katanga, Anabor, Olonek, Lena, Jana, Indigirka, and Kolyma, all of which pour their waters, more or less heated during the hot summer of Siberia, into the Polar Sea and render it, during a short period, almost free of ice.

On the night between August 27 and 28 the Vega parted from the Lena off the mouth of the River Lena. There is scarcely any hope now that the voyage will be completed before next summer. No doubt the Vega has got into a safe winter harbor, and that during the detention of the expedition a harvest of scientific results will be gathered.—*Nature.*

[Continued from SUPPLEMENT 157, page 2489].

## GALVANIC BATTERIES.

### II.

By GEO. M. HOPKINS.

*The Daniell Battery*, Fig. 16, is scentless, and does not develop any poisonous vapors, and hence may be used anywhere without fear of endangering health or acting disadvantageously on the metallic parts of the surrounding apparatus. The glass vessel, G, is filled with a solution of sulphate of copper. The porous cell, P C, contains the zinc, Z. The curved sheet of copper, C, has attached to it a perforated pocket, *c*, for containing crystals of sulphate of copper. The porous cell may be filled with a solution of common salt or water slightly acidulated.

This battery is especially adapted for closed circuits; it is less suitable for open circuits.

The cut is about ⅛ of full size.

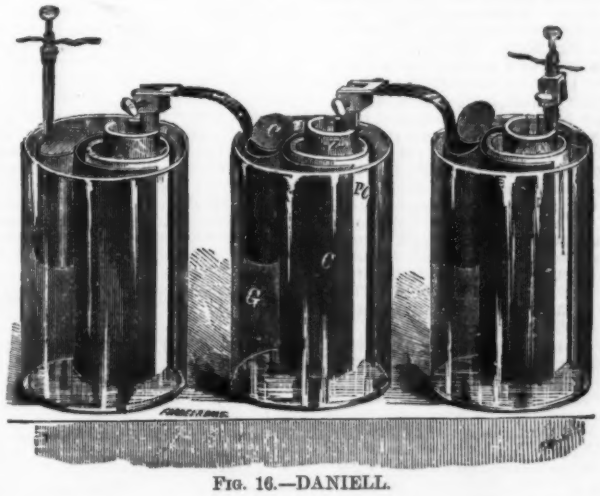


FIG. 16.—DANIELL.

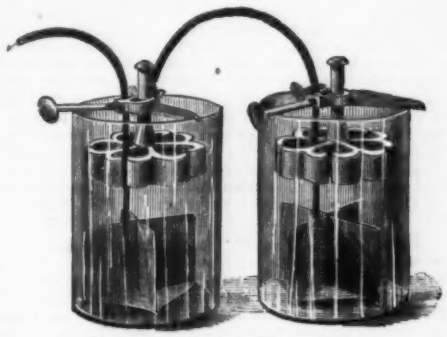


FIG. 19.—GRAVITY (ordinary).

*The Siemens-Halske Battery*, Fig. 17, is a modification of the Daniell. It differs from the latter substantially in improvements in the diaphragm.

A is a glass vessel; *c*, a glass tube; *k*, a perpendicular copper plate bent into spirals, and having attached to it a wire; *b c*, is a thin paste-board disk; *f*, the diaphragm in place of the porous cell, formed of a peculiarly prepared mass of paper. Z is a zinc having a binding post, *h*. The mass of paper must be well compressed, and afterward a fourth part of its weight of sulphuric acid is poured over it and stirred up until the whole mass has become homogeneous and glutinous. Then four times as much water is added to it and worked with it; the superfluous sour water is removed under pressure. The inner glass cylinder, *c*, is filled with crystals of sulphate of copper, and water is poured on it.

The space around the tube, *c*, is filled with acidulated water, or with a solution of common salt. Afterward it is only necessary to keep the inner cylinder always filled with crystals of sulphate of copper, and now and then renew the water in the outside vessel.

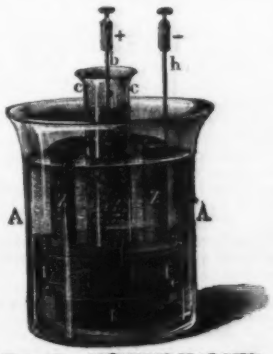


FIG. 17.—SIEMENS-HALSKE.

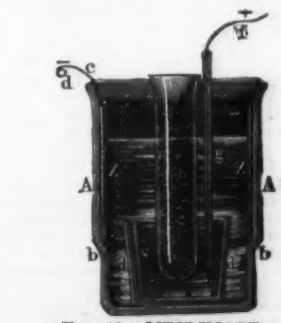


FIG. 18.—MEIDINGER.

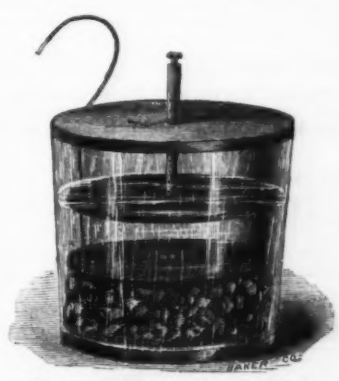


FIG. 21.—GRAVITY (with Disks).

The zinc is not amalgamated. The paper is covered with a ring, *g*, of coarse cloth, which is replaced by a new one whenever the battery is cleaned, which should be once in two weeks. These elements have generally too much resistance for local batteries, but they are admirably adapted for working long lines.

Cut, about ⅛ natural size.

*The Meidinger Battery*, Fig. 18, is a modification of the Daniell battery, but it has no porous cell, and possesses greater durability and constancy of current. It consists of a glass vessel, A, 8 inches high and 5 inches wide, in the bottom of which is placed a small glass vessel, *d*, of half the size of the larger glass. This vessel is cemented to the bottom of the larger one with rosin. A hollow zinc cylinder, Z, which is supported on a ledge of the outside vessel, surrounds the smaller glass. The inside wall of the smaller glass, *d*, is covered by a sheet of copper, *e*, on the lower end of which an insulated copper wire, *g*, is riveted. The mouth of the larger vessel is closed by a wooden or tin plate, having an opening in the center for the reception of a glass cylinder, *h*, 1½ in. diameter and 8 ins. high, narrowing toward the lower end, which is rounded and in which a small hole is made. This tube is sunk to the center of the small glass, *d*. The larger vessel is nearly filled with a dilute solution of Epsom salts (1 part of salts to 4 or 5 of water). The glass tube, *h*, is filled with crystals of sulphate of copper, forming a concentrated solution which, being the heavier fluid, sinks downward through the small hole in the glass tube, and fills the glass, *d*, to the center.

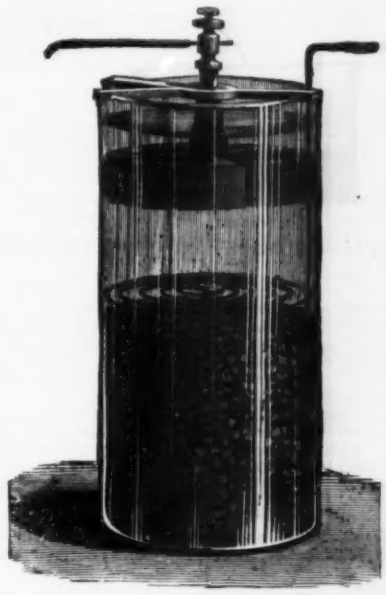


FIG. 20.—GRAVITY (with Wire Spirals).

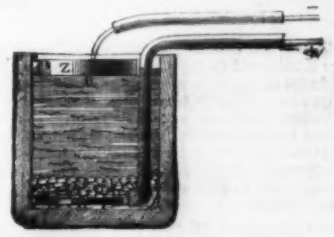


FIG. 22.—MENOTTI.

The zinc is usually amalgamated.

Cut, about ¼ full size.

*The Gravity Battery*, which is shown in its simplest form in Fig. 19, consists of a glass jar about 8 ins. high and 6 ins. diameter, having a zinc casting suspended near the top, and a copper plate is placed on the bottom and provided with a gutta-percha-covered wire leading out of the jar. One or two pounds of sulphate of copper are placed on the bottom of the jar, and enough water is poured in to cover the zinc about 1 inch. After standing 24 to 36 hours, the battery is in condition to operate. As the name of this battery indicates, its action is dependent on the separation of the sulphate of zinc, which is formed at the top of the jar, and the sulphate of copper solution, which gravitates toward the bot-

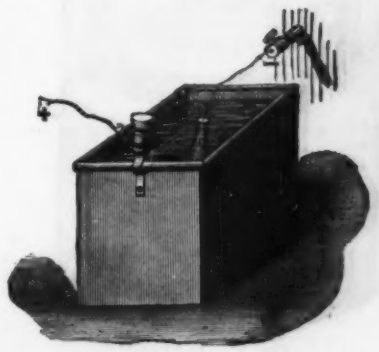


FIG 23.—THOMSON'S MODIFICATION OF MENOTTI.

tom of the jar. When the two solutions have properly separated, the fluid in the lower part of the jar will be blue, and that in the upper part will be nearly colorless or transparent. The zinc should always be suspended in the colorless fluid, and as the blue fluid decreases the zinc should be lowered from time to time to reduce internal resistance.

When the water in the upper portion of the jar becomes saturated with sulphate of zinc, the sulphate crystallizes upon the zinc plate, stopping the action of the battery. The conducting power of a solution of sulphate of zinc is greatest when the sulphate is diluted with an equal quantity of water. Part of the solution, therefore, should be from time to

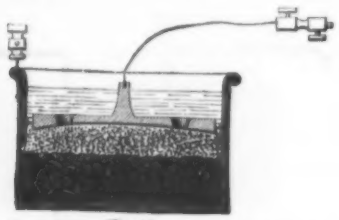


*Fig.* 40.

FIG. 24.—THOMSON'S MODIFICATION OF MENOTTI.

time removed, and replaced by water. Undissolved crystals of sulphate of copper should always remain in the bottom of the jar. The jars should not be disturbed when in use, as this would cause the solutions to mix. As the water evaporates it should be replenished. The battery should be cleaned about every four months.

A form of Gravity battery is shown in Fig. 20, in which the negative element consists of two flat spirals of copper wire, and in another variety shown in Fig. 21, two copper disks are used in place of the spirals.

*The Callaud Battery* is substantially the same as the Gravity batteries above described.

*The Menotti Battery*, shown in Fig. 22, is a modification of the Gravity battery. A gutta-percha-covered wire is soldered to the copper disk at the bottom of the vessel, and another wire is soldered to the zinc. Crystals of sulphate of copper are placed on the copper disk, and above the crystals there is a three-inch layer of saw-dust, and the zinc rests upon the saw-dust, which is wet with water. The cells are usually about 4 inches diameter inside, and 5 inches high. The metal plates are about 3½ ins. in diameter. This form of battery is portable and constant. It is chiefly used for testing purposes, and is well adapted for use at sea.

Cut, about ¼ full size.

*Sir William Thomson's Battery* is a modification of Menotti's. It is an excellent form of battery for experimental or other purposes, requiring very low internal resistance, combined with convenience and economy of management.

FIG. 26.—WATSON.

It is known as the tray battery. The coppers are made in the form of trays, with inclined sides, 18 or 20 inches square and about 3 inches deep, each tray resting directly upon projections cast upon the upper surface of the zinc of the cell beneath. The zinc is usually made in the form of a grating. Another very convenient and useful form of this battery is shown in Figs. 23 and 24, the latter being a vertical transverse section. It consists in a containing vessel of sheet lead, in the bottom of which are placed five or six pounds of sulphate of copper. This is covered with a layer of clean fine saw-dust from one to two inches thick, upon which the zinc plate rests. The vessel is then nearly filled with soft water, or if quick action is desired, a solution of sulphate of zinc. This battery will give a strong and perfectly uniform current from three months to a year (according to the work done by it) without any attention whatever. The internal resistance is very low.

*The Muirhead Battery*, Fig. 25, is now in general use for telegraphic purposes in England. The zinc plates are about 4 inches long by 3 inches wide, and the copper plates about 4 by 3 inches. The porous cells are filled with a solution of sulphate of copper, and the outer cells, which are made of white porcelain, in pairs, are filled with very dilute sulphuric acid. Five such pairs are inclosed in a strong teak-wood case, with a lid through which gutta-percha-covered wires project at the ends. Crystals of sulphate of copper, of the size of a hazel nut, are placed in the porous cells to maintain the solution in a saturated condition. The copper connecting strap is cast in the zinc, having been tinned to insure adhesion. To check endosmosis, or the tendency of the two fluids to mix through the porous cells, they are greased, except on the portion opposite the zinc plate. This, however, does not entirely prevent the mixing of the two solutions.

*The Watson Battery*, Fig. 26, has a central leaden tube, which rests upon the bottom of the jar and reaches to the cover. The lower end of the tube is conical and perforated. The annular zinc is suspended from the cover and placed in communication with one of the binding screws, the other binding screw connects with the leaden tube. To charge the battery, fill the jar nearly two-thirds full with a mixture of one-quarter pound sulphate of zinc to two quarts of water. Then put the tube and zinc and cover in position as shown in the cut below, and drop into the tube at the top from one-half pound to three pounds of blue vitriol. If the battery is not to be used very constantly, the lesser amount of blue vitriol will do, but if the battery is to be worked steadily, fill up the tube with blue vitriol.

This battery is said to be stronger than Daniell's. The jar in this battery is 9 ins. high and 6 ins. diameter.

*(To be continued.)*

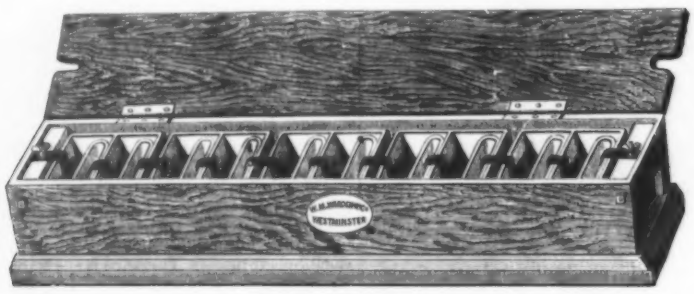


FIG. 25.—MUIRHEAD.

## THE DIVISIBILITY OF THE ELECTRIC LIGHT.

THE English and American periodicals devoted to electrical science now announce, "on authority," that the electric light discovered by Edison is a light by incandescence. If this be true there is nothing new or startling either in the discovery of the light or of its divisibility. Lighting by incandescence has been studied for a long time; indeed, it has been studied much more thoroughly than any other kind of electric lighting. Thirty-three years ago a method of producing and sub-dividing the light was patented in England by a Mr. King. The light was produced by heating to white heat in a vacuum, by means of the electric current, either platinum or carbons; and, the specification adds, "when the current is of sufficient intensity, two or a larger number of lights may be placed in the same circuit." For some years after this discovery several improvements on King's invention were patented in America, France, and England; "but," says M. Fontaine, "none of these appear more complete, more explicit, and more practicable than King's; it is, then, useless to continue our nomenclature." The principle of lighting by incandescence, although not neglected or forgotten, seems to have made but little progress until 1871, when M. Lodyguine showed an experiment in the Admiralty Dockyard in St. Petersburg, when he divided the circuit into no less than two hundred lights. This naturally made a great sensation at the time—as great a sensation as that caused by Mr. Edison's telegram of Nov. 7th. The Academy of Science awarded to M. Lodyguine the large Lomonossow prize of 50,000 roubles. A company was formed in St. Petersburg with a capital of 200,000 roubles, and the excitement in Europe was then almost as great as has been witnessed in England lately It was soon found, however, that Lodyguine's discoveries, like those of his predecessors in the same field, were, after all, impracticable, and that his illimitable division of the light, however ingenious, was only a fanciful experiment. Every penny subscribed to the company referred to was lost, and Lodyguine's great discovery is now, where it was then—in his laboratory.

It has, however, been urged that the early inventors of the electric light knew only of the galvanic battery as a generator of a powerful current, and that had they known of the Gramme machine, or other dynamo or magneto electric machine, the results might have been different. The remark, however, only applies to King and the improvers who immediately succeeded him. The great division of the light by Lodyguine, to which reference has just been made, was in a circuit produced by two "Alliance" machines. Even, however, if such were not the case, there are at present before the world, in more or less detail, four recent inventions for the production of a divided light by incandescence. These are the inventions of M. Reynier, of M. Arnaud, of Mr. Edison, and most recent of all, M. Werdermann. From the way in which these discoveries—if they are discoveries—have been ushered into the world, it is found that great claims are made on their behalf, and there are, therefore, naturally great expectations on the part of the public in regard to them. It cannot be urged now in mitigation of the shortcomings of the incandescent light, as it has been urged in the past, that it has not had a fair trial, on the ground that the lamps in existence were imperfect in conception and complex in construction. The lamp of M. Reynier seems admirable in its way, and if light by incandescence were to be the light of the future, the claims of this lamp would have to be very carefully considered, and, in any case, it will certainly hold an important place in all investigations into the subject. The lamp of M. Werdermann appears to be identical in principle with, and only slightly different in detail from, that of M. Reynier, and we may fully expect that these inventors will have to come to terms with each other—so much alike are their inventions. Of the details of Mr. Edison's invention—if there are any, nothing is known beyond the fact stated in the SCIENTIFIC AMERICAN, that it is a light produced from a spiral of incandescent platinum; while the reports in the American daily press show such an effervescent ignorance of the fundamental principles both of electricity and of dynamics, that no reliance whatever can be placed upon them.

Experience, then, has shown that a light by incandescence comes before us in a very questionable shape, and it is essentially a light which discourages the notion of its practical application. The question indeed may be very properly asked: How is it that light by incandescence has always proved such an utter failure? It has had a period of thirty-three years in which to develop; it has been divided into various lesser lights, numbering from two to two hundred; and it has arrested the attention and taxed the skill of the greatest electricians in the world. How is it that it is obliged to give way to light by the voltaic arc? The answer is at hand. The light by incandescence can only be obtained and divided by a great sacrifice of light and power. This is imperative from the fundamental principles of electrical science. The diminution, according to the "square," and not according to simple proportion, applies to electricity just as it applies to light, heat, sound, gravitation, and other physical phenomena. Thus if a circuit be divided into two branches whose resistances are equal, a current of half the strength passes through each branch, producing at the point of resistance, not half the light, but only a quarter, because the effect follows the square of the current strength. If the current had been divided into three equal branches, in each branch only one-ninth part of the original light would be obtained, and so on; so that if an electric light of 1,000 candles were divided into ten equal lights, the result would be ten lights of ten candles each, instead of one of 1,000 candles. When this law is borne in mind, and when it is also remembered that to produce the electric light by incandescence at least one-half of the current is lost, it will easily be imagined what a wasteful light it is. Recent experiments prove this. It was recently stated, in reference to M. Werdermann's incandescent light, that he produced two lights of 320 candles each (total, 640 candles), with a prime mover of 2 horse-power; and this was considered a great result—as indeed it was for an incandescent light. But how this sinks into insignificance when compared with the results of lighting by the voltaic arc. A few days ago M. Rapieff, with two of his regulators and a small Gramme machine known as the M machine, and which M. Gramme says requires only 1½ horse-power, produced two lights, which, when carefully measured by the photometer, were found to be each equal to 1,150 candles, or a total of 2,300 candles, while with one of M. Gramme's A machines, requiring 2½ horse-power, a light of 6,000 candles can be obtained from one of M. Rapieff's regulators. Some experiments detailed in M. Fontaine's book on "Electric Lighting" gave a similar result. M. Fontaine's experiments with an incandescent light show that under the most favorable circumstances, with a Bunsen battery of forty-eight cells, eight inches high, the diminution of the sub-divided light was so great that, where he put five lights in one circuit, he only obtained a total illuminating power of a quarter of a burner, with four lamps only three-quarters of a burner, with two lamps six-and-a-half burners, and with one lamp fifty-four burners. These numbers give the following ratio: 1, 3, 8, 26, 216, thus showing how rapidly the light diminishes when divided. With the voltaic arc, however, and with the same battery, he was able, by a Serrin lamp, to obtain a light of 105 burners.

It will be seen, then, from what has been above stated, that the production and the divisibility of the light by incandescence is a very wasteful process—so wasteful, indeed, as to render its practical application impossible for general lighting. If, therefore, all Mr. Edison has to announce to the world is that he has succeeded in dividing an incandescent light—and the announcement that such is so is made on authority—his discovery amounts to very little. Both the light and its divisibility were discovered long ago. It will easily be seen that it is not in that direction that any great practical results can be obtained. The voltaic arc supplies the only divisible light of any utility and economy, and it is in its development that any real progress must be looked for.—WILLIAM TRANT, *in Nature*.

## ACTUAL COSTS OF USING ELECTRIC LIGHTS.

A PAPER was lately read before the Society of Arts, London, by Mr. J. H. Shoolbred. The value of the paper consists simply in its bringing together the data required for a fair consideration of the economy of the electric light. It contained nothing not known before, but the facts have hitherto been difficult of access.

In some cases these machines were illustrated by full-sized diagrams placed on the wall, and at the end of the paper a few words of explanation were given. The author mentioned that at the lighthouses at Souter Point and South Foreland the lighting apparatus consists of two Holmes machines, driven by 10-horse power engines—nominal. A single light is produced with an average intensity of 1,523 standard candles, two machines, when coupled, giving a double intensity of light. The cost is about £1,035 a year, or nearly 5s. an hour.

At the Lizard Lighthouse a series of six Siemens dynamo-electric machines of the type known as 4,000 candles are used, driven by three caloric engines. The hourly expense, calculated as above, taking a total of 4,012 working hours in the year, is just over 2d.

Attention was here directed to the fact that the requirements of lighthouses were quite different from those of ordinary business premises or streets, and that no comparison could be made in these cases.

As examples of the use of the electric light to business purposes, its use at the goods station at La Chapelle, Paris, and the ironworks of Messrs T. & T. Powell, of Rouen, was mentioned. At the former it was said that the nightly working expenses, with an average of four lights and during ten hours, were found to be—

| | s. | d. |
|---|---|---|
| Motor power—2·5 H. P. × 7·8 lb. coal × 10 hours × 4 lamps | 7 | 0 |
| Carbons—4 lamps × 10 hours × 1¼d. (nearly) | 4 | 10 |
| Oil 8d., wood 1¼d., lighting engine shed 2¼d. | 1 | 0 |
| Engineman's wages | 4 | 0 |
| | 16 | 10 |

This gives a price per light per hour of 5d.; add to this 10 per cent. on first outlay of £1,640 for interest and depreciation, 2¾d.; total cost per light per hour (say 8d.) 7¾d. This

to the railway company, would represent the cost of twenty-two gas jets, while the electric light in the shed was considered to have satisfactorily replaced fifty-two jets, thus leaving an economy of thirty jets, or about 60 per cent. in favor of the electric light.

The light has been in use here since January 15th, 1877. A series of careful experiments have been carried out by the officers of the company. The results show that on an average 2½ actual horse-power is required per light per hour, sometimes a little more, sometimes rather less; and that the square carbons of ⅜in. a side were consumed at the rate of 4in. per hour, or at a cost of 1½d., waste included.

Messrs Powell, after two years' experience in their erecting shed, find the electric light much cheaper and more effective, and have decided to extend it without delay to the whole of their works. Several examples of the third period were referred to, one of which may be given as typical of the success attained. The Western Railway of France early in 1878 applied the Lontin system to their goods yard at the Paris terminus—St. Lazare. For this purpose, six electric lights are placed against the columns which carry the roof, at a height of about 12ft. from the ground. They are provided with electricity from a Lontin—double—machine, of the type known as of "12,000 candles." The motor power being afforded by an agricultual engine of 8-horse power nominal, the piston being 9½in. in diameter and 13½in. stroke, the average pressure in the boiler being 88 lbs. per square inch, and 110 the average number of revolutions per minute of the fly-wheel—the total hourly consumption of coal per hour being about 80 lbs.—the lights were found, by a series of careful experiments—of which later on—to be of a mean luminous intensity of 480 candles each. They are generally left naked, without any shade, without any ill effect being produced upon the persons below.

The lamps used are the Serrin, modified by Lontin, so as to admit of several being placed upon one circuit; in this instance they are placed in pairs, six lamps upon three circuits. The consumption of the ⅜ round carbons was found to be at the rate of 1½d. per light per hour. The average working expenses of these six lights are, per hour—

| | s. | d. |
|---|---|---|
| Coal, &c., for engine, at 32s. per ton | 1 | 2 |
| Carbons for six lamps | 0 | 8 |
| Engineman and stoker | 0 | 10 |
| Total hourly cost for six lamps | 2 | 8 |
| Or per light per hour | 0 | 5⅓ |
| Add for interest on outlay for depreciation and repairs | 0 | 2⅔ |
| Total hourly expense for each light | 0 | 8 |

In conclusion the Jablochkoff light, as used in the Place and Avenue de l'Opera and other parts of Paris, was mentioned, and the conclusion arrived at was that the system was to all intents and purposes obsolete, inasmuch as the expense was enormous. The loss to the company promoting the use of this light was shown to be very great, and, it is stated, that notwithstanding the loss, the Société Générale d'Electricité have consented to continue the lighting at a reduced rate. The price paid to them will be, up to January 15th next, at the highly remunerative rate of about 1½d. per light per hour, for what, on their own statement, costs nearly 11d.

[Continued from SUPPLEMENT Nos. 144, 146, and 153.]

## OUTLINES OF CHEMISTRY.

By HENRY M. McINTIRE, M.E.

COPPER (atomic weight, 63·5; symbol, Cu). Copper is one of the earliest known metals. It was in use long before iron, both as copper and in combination with tin. It is so well known that it hardly needs description. It possesses a deep red color, very great tenacity, and is very malleable and ductile. It melts at a red, and is slightly volatilized at an intense white heat, tingeing a flame, then, green. When exposed to the air, dry or moist, or to pure water, it is not affected. Besides its very many uses in the arts, as a metal it is quite important as a constituent of alloys. With zinc it forms brass, and with different proportions of tin, bronze, bell metal, gun metal, or speculum metal, as the case may be. There are two important oxides of copper, $Cu_2O$ and CuO.

Suboxide of copper, cuprous oxide, or red oxide of copper, $Cu_2O$, occurs in nature, and may easily be prepared artificially. It unites with acids to form the cuprous salts, which are not stable, changing rapidly in the air to the cupric.

Cupric oxide, or black oxide of copper, CuO. This is the oxide that is formed when heated copper is acted upon by the atmosphere. It is a quite useful agent in analytical chemistry. It unites with acids to form the cupric salts, of which may be mentioned cupric sulphate ($CuSO_4.5H_2O$), commonly known as blue vitriol, a substance employed in the manufacture of several pigments, in calico printing, in the galvanic battery, etc.

Lead (atomic weight, 207; symbol, Pb). Lead is a quite ancient metal, that is, if the age of a metal depends on the length of time that it has been known to man. It is, as is well known, of a bluish white color, quite soft, and almost a failure with regard to ductility and tenacity. In perfectly dry air the surface of the metal remains untarnished, but, if the air be moist, a film or oxide soon forms. In pure water lead is unchanged, but if the water be impure it attacks the metal, and in some cases dissolves some of it; and as lead is poisonous, and is often used for water-pipes, the question of "lead poisoning" is one of vast importance. It is a certain fact that all kinds of water will not dissolve the metal; which will and which will not is, however, an open question. It may be set down, however, that if water contains free carbonic acid it will be injured by contact with lead, as carbonate of lead will be formed, which is soluble in water containing carbonic acid. If the water contains *carbonates* it may be regarded as safe, for carbonate of lead will be formed as a coating on the metal, which will be insoluble in the water (that is, if no *free* carbonic acid be present); the same thing may be said of sulphates. But for water containing chlorides or nitrates the case is the reverse.

The alloys of lead are quite important: shot lead (lead and arsenic), type metal (lead and antimony), may be mentioned. There are three oxides of lead, PbO, $PbO_2$, and $2PbO,PbO_2$.

Litharge, or lead monoxide, PbO. The oxide formed by the action of air in melted lead. Its color varies from straw yellow to yellow red, depending on the method of preparation. It forms with acids the lead salts.

Lead dioxide, or punk colored oxide of lead, $PbO_2$, a brown powder, which, when heated, yields up half of its oxygen and is changed to the monoxide. It does not form a series of salts.

Minium, red lead, or red oxide of lead, $2PbO,PbO_2$. A mixture of the two preceding oxides. Used chiefly in the manufacture of flint-glass. Of the salts of lead of much importance are lead acetate, or sugar of lead, and lead carbonate, or white lead.

Thallium (atomic weight, 204; symbol, Tl). A metal that was discovered by Mr. William Crookes, of London, in 1861, by means of the spectroscope. It occurs in iron pyrites, where it seems to take the place of arsenic. It resembles lead very much in its physical properties. It has two oxides, $Tl_2O$ and $Tl_2O_3$.

Mercury (atomic weight, 200; symbol, Hg). Mercury is one of the metals earliest known to man. It derives its name from the Greek, meaning liquid silver, for what reason is obvious. It is the only metal liquid at the ordinary temperature, solidifying at 39° below zero, and boiling at 662° above, although it slowly volatilizes at all temperatures. It is not oxidized at ordinary temperature, but at about 750° it rapidly absorbs oxygen, forming the red oxide. It is used to a great extent in metallurgy, for the extraction of gold and silver from the ores. Many of the amalgams are of great use in the arts. Some of its salts are quite valuable in a medical way, others for pigments. Mercury forms two oxides, $Hg_2O$, HgO.

Suboxide, or black oxide of mercury, or mercurous oxide, $Hg_2O$, can easily be prepared, but is very unstable, passing upon the least provocation into the red oxide and the metal. With acids it forms the mercurous salts, of which mercurous chloride, or calomel (HgCl), is quite important.

Red oxide of mercury, or mercuric oxide, HgO. Much more stable than the preceding, but not so much so that when heated to redness it will not be changed to oxygen and mercury, for which reason it is often employed as an oxidizing agent. It forms with acids the mercurous salts, of which mercuric chloride, or corrosive sublimate, $HgCl_2$, may be mentioned.

Silver (atomic weight, 108; symbol, Ag). This is another of the metals first known to man. It occurs in nature, both native and in ores, from which it is quite easily extracted. It is of a pure white color, quite hard, quite malleable and ductile, and is probably the best conductor of heat and electricity known. Silver is not affected by the air at any temperature. It stains glass yellow to orange; is but slightly attacked by hydrochloric acid. Boiling sulphuric acid changes it to sulphate, but nitric acid, hot, cold, strong, or dilute, dissolves it quite readily. It has also a great affinity for sulphur, forming with it the black sulphide. This is the cause of the tarnishing of silver. There are two principal oxides of silver, $Ag_4O$, $Ag_2O$.

The suboxide, $Ag_4O$, is a black powder, very unstable. It forms with acids the lower series of silver salts which are of so little importance (and very, very unstable, by the way) that they need hardly be spoken of.

Silver oxide, $Ag_2O$, is of a brown color, being decomposed into oxygen and silver at a red heat. It forms the well-known series of silver salts of which silver nitrate is, perhaps, of the most importance. Its properties are too well known to require description. The like may be said of the chloride, iodide, and bromide.

Gold (atomic weight, 197; symbol, Au). The exceptions are so very, *very* rare, that it may be said that gold *always* occurs in nature in the metallic state, and with the exception of iron as the most widely distributed metal known (that is, of the metals that are made use of in the *metallic state*). For example, there is enough of it in the clay underlying the city of Philadelphia to pay the national debt, in all probability; and when it is remembered that the stratum underlying this auriferous clay is generally richer in the metal than the clay is, it must be acknowledged that Philadelphia, of all places, is certainly "upon a hard money basis." This metal is quite soft, of a bright yellow color, may be drawn into wire, and is the most malleable of all metals. Selenic acid is the only simple acid that acts upon it. Free chlorine and nitro-hydrochloric acid succeed in dissolving it, however. It has two oxides, the suboxide, $Au_2O$, and the oxide, AuO. The salts of gold are of but little use, the chloride being, perhaps, the only one that is utilized. The standard gold of the country—that is, the metal used for coin—is 900 fine; that is, there are 900 parts of gold to 100 of the alloy, silver. It might have been well to have said, under silver, that standard silver is 900 fine (the alloy being copper). The United States uses the decimal system of fineness, similar to France; on the other hand, England uses the duodecimal; her gold and silver having one-twelfth of alloy.

Platinum (atomic weight, 197·4; symbol, Pt.) Platinum is quite rare, occurring always in the metallic state. It is a white metal, which will take a very high polish. Not very hard, quite ductile and tenacious, and very infusible. It is affected by acids in exactly the same way as gold, except that selenic will not affect it. Alkalies at a high temperature attack it to an appreciable extent. Chlorine has no effect upon it. It has two oxides, the protoxide, PtO, and the binoxide, $PtO_2$. Its salts are of but little use; it, itself, is chiefly used for dishes and crucibles, in chemical laboratories, for which it is peculiarly fitted.

Palladium (atomic weight, 106·5; symbol, Pd). A very rare metal occurring in the ores of platinum; was discovered by Wollaston in the year 1803.

Rhodium (atomic weight, 104·3; symbol, Ro). Was also discovered by Wollaston in 1803. It usually forms about one-half of a per cent. of the ores of platinum.

Ruthenium (atomic weight, 104·2; symbol, Ru), is another metal which occurs in very small quantities in the ores of platinum. It was discovered by Clausen, in 1845.

Osmium (atomic weight, 199; symbol, Os). Like the preceding three, it occurs in platinum ores; was discovered in 1803 by Tennant.

Iridium (atomic weight, 197·1; symbol, Ir). Occurs in the same way as osmium, and was discovered by the same person at the same time.

This, then, ends inorganic chemistry.

### ORGANIC CHEMISTRY.

As the domains of organic chemistry are almost boundless, as the entire subject is by far the most complicated division of chemistry, and as to treat it with the same degree of completeness or incompleteness as the inorganic division requires far more space than that required for inorganic chemistry, no effort will be made here to speak in a general way of organic chemistry, neither will it be required. Of course the theoretical part is based on the principles laid down at the very beginning of this series of articles. A few of the most important organic substances will be mentioned, almost at random, and with that these articles will close.

Ethyl alcohol, $C_2H_6O$, is produced in the vinous fermentation of sugar. The solution of sugar is fermented, and the alcohol separated by distilling, being repeatedly distilled to separate from the water. It is a colorless, volatile liquid, with a characteristic and pleasing odor and burning taste. It is a solvent for very many substances.

Ether, $C_4H_{10}O$, called often sulphuric ether, although in chemistry sulphuric ether is another substance than this, which is there known as ethyl-ether. It is called sulphuric ether, in common parlance, because it is made from alcohol by means of sulphuric acid. When alcohol is added to sulphuric acid, ether and water are given off. It is a very valuable liquid, having a characteristic smell; its vapor is inflammable, and even explosive when mixed with air.

Acetic acid, $C_2H_4O_2$, may be prepared by the direct oxidation of alcohol. When alcohol is changed to acetic acid, acetic fermentation is said to have taken place.* This acid is a colorless liquid, solidifying at a temperature of 63°, from which it is called "glacial." It has a peculiar smell, and mixes with water in all proportions. It will not then solidify at the temperature given above, and is no longer "glacial." It forms with bases the series of salts known as acetates.

Oxalic acid, $C_2H_2O_4$, occurs in crystals, which are decomposed by heat into carbonic acid, carbonic oxide, and formic acid. With bases it forms oxalates, which may be either neutral or acid.

Tartaric acid, $C_4H_6O_6$, occurs in many plants and the juice of many fruits. It is obtained in large crystals, easily soluble in water. It forms tartrates with bases, which may be either acid or neutral. The neutral potassic tartrate is deposited during the fermentation of wine, and is known as tartar. The acid potassic tartrate is known as cream of tartar, and the double tartrate of potassium and antimony as tartar emetic.

Citric acid, $C_6H_8O_7$, occurs in many fruits, notably in the lemon. It is obtained in large crystals, soluble in water. It forms citrates, which may be acid, neutral, or basic.

Glycerin, $C_3H_8O_3$, occurs in most fats and oils, united with a fatty acid. Thus in stearine it is united with stearic acid, as glycerin tristearate. In soap-making the acid is united with an alkali to form an alkaline stearate (soap) and the glycerin is liberated. It is a thick, sirupy liquid, colorless, and heavier than water. It mixes with alcohol and with water in all proportions. If it be acted upon by strong nitric acid, trinitroglycerin is formed, the violent explosive so useful in engineering operations.

Saccharine bodies, of which it may be mentioned that there are three classes: 1. Sucroses, or sugars proper; 2, glucoses, or grape sugars; and, 3, amyloses, or starch and woody fiber. Of the sucroses, or sugar proper ($C_{12}H_{22}O_{11}$), sucrose, or cane sugar, and lactose, or milk sugar, and of the glucoses, or grape sugars ($C_6H_{12}O_6$), dextrose, or grape sugar, and levulose, or fruit sugar, may be mentioned, and of the amyloses, or starch and woody fiber ($C_6H_{10}O_5$), starch, setrim, gums, and cellulose may be instanced.

*Starch* occurs very widely in the vegetable world. It is insoluble in cold water, but becomes soluble in boiling. When heated to 320°, it is converted into dextrin, or British gum.

*Cellulose*, "the colorless material of the woody fiber of young plants," may be seen in a nearly pure state in cotton or linen fiber. When acted upon by strong nitric acid, it becomes very inflammable, even explosive, and also soluble in ether and alcohol. This is, of course, nitrocellulose ($C_6H_7(NO_3)_3O_5$), gun-cotton, or soluble cotton.

And, with this, organic chemistry is ended, although, probably, many important substances have been left unmentioned—an excusable omission, when it is remembered that organic chemistry includes all of the vegetable and animal kingdoms.—*Phila. Photographer.*

## AMMONIUM NITRATE.

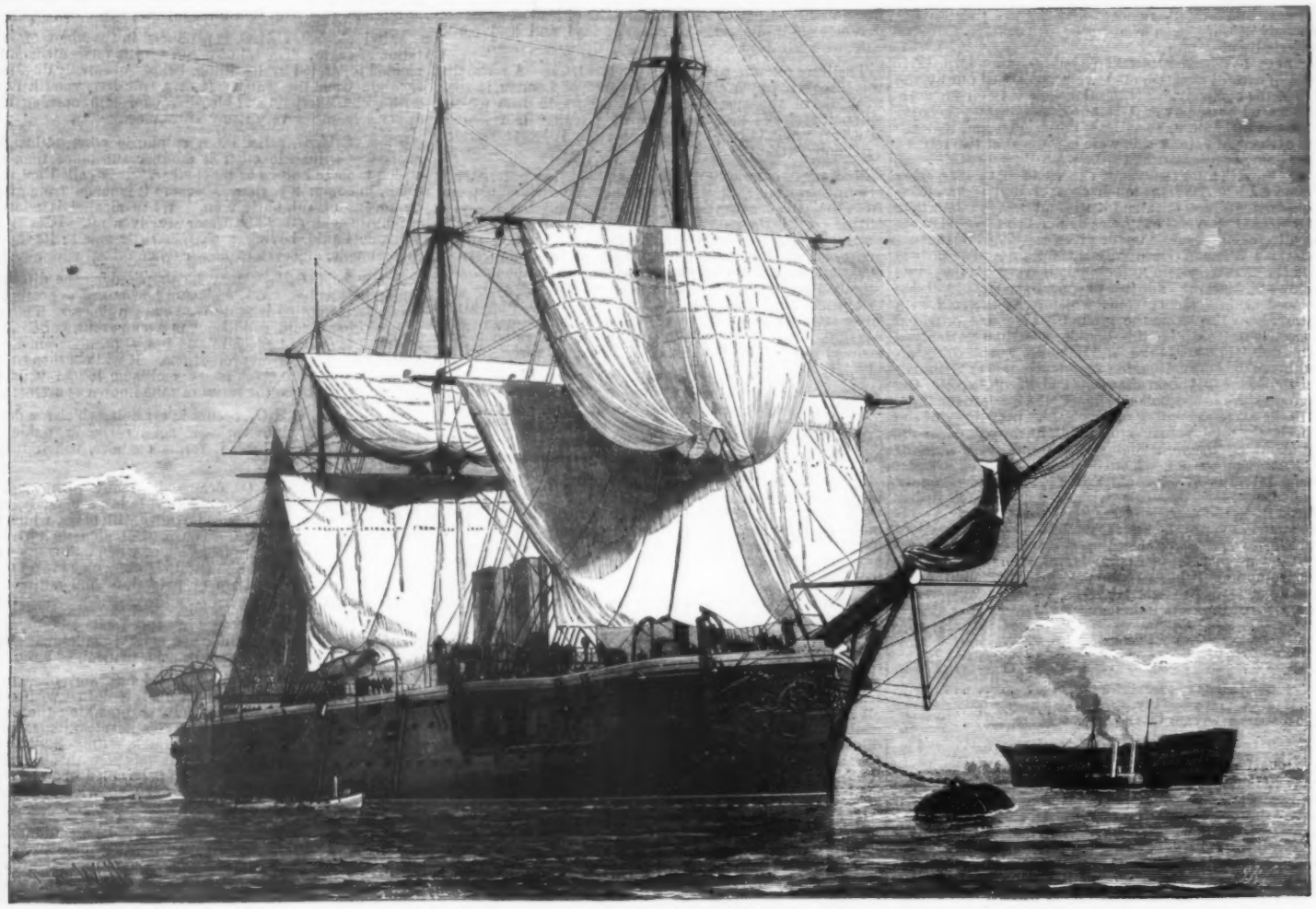
By SPENCER PICKERING.

THE melting point of ammonium nitrate given in the various text books is apparently incorrect. In the "Dictionary of Chemistry" it is stated to be 108° C.; in Miller, 107·8° C.; and in Gmelin it is stated that it melts imperfectly at 56° C., and perfectly at 108° C. But experiments on the crystallized substance, which had been dried at 100° C., invariably gave its melting point at 165° to 166° C., whether it had been recrystallized from water or from alcohol; it was also found that the amount of water retained by the moist crystals after being pressed between blotting paper (about 0·55 per cent.) did not lower its melting point more than 3° C.

Ammonium nitrate dissolves easily in alcohol, but is much less soluble in this liquid than in water. From either its alcoholic or aqueous solution it is deposited, on cooling or on evaporation, in anhydrous crystals, which deliquesce only when exposed to very moist air. Portions of the substance which had been dried at 100° C., and which weighed about 1 grm., were exposed on watch glasses to the air of the laboratory for about eighteen hours; crystals obtained from an alcoholic solution gained in this way 0·06 per cent. of moisture; and those obtained from an aqueous solution gained in one case 0·06, and in another 0·15 per cent.; crystals which have been dried by being pressed between blotting paper will even lose a portion of the small amount of moisture which they contain, the loss varying from 0·01 to 0·1 per cent. Some of the powdered substance which had been dried at 100° C. was exposed to the air of the laboratory for ten days, after which it was found to contain 0·09 per cent. of water, but on subsequent exposure to air perfectly saturated with moisture for twenty-two hours, it absorbed as much as 14 per cent. of water. In another experiment, where the crystals had been obtained from an alcoholic solution, the absorption amounted to 32 per cent. Some of the fused salt gained under similar circumstances 3·3 per cent., becoming, as in the two previous experiments, partially liquefied. Ammonium nitrate is insoluble in ether.

On being heated above its melting point, it begins to decompose into nitrous oxide and water at about 185° C.; and not at 250° C., as stated in Miller and elsewhere.—*Chemical News.*

* As a homely illustration of alcoholic and acetic fermentation, cider may be mentioned. When first made, it contains quite an amount of sugar, but fermentation takes place. Alcohol is produced, and we have "hard cider;" time goes on, the alcoholic fermentation is completed, and the acetic fermentation takes place, the alcohol becomes acetic, and we have vinegar.



THE NEW STYLE OF BRITISH IRON CLADS.—H. M. S. NORTHAMPTON.

H. M. S. NORTHAMPTON.

THE Northampton, of which we here give an illustration, has been fitted out at Chatham Dockyard. She is a sister ship to the Nelson, another of the new type of ironclad ships, having only their vital parts protected, and having a reserve of flotation. The Nelson and the Northampton may be considered in some measure as rival ships, both having been built by private firms. The Northampton is from the yard of Messrs. Napier, Glasgow, and was engined by Messrs. Penn, Greenwich; and the Nelson has been built and engined by Messrs. John Elder & Co., Glasgow. The trials were in every way satisfactory. From the periodical return of the strength of the Royal Navy just issued we find that within the past six months nine vessels, of various tonnage and power, have been launched, and that at the present time there are seventeen others under construction or about to be built at the various Government dockyards and by private firms. The vessels now being completed for service are five out of the six screw-corvettes built of steel and iron and cased with wood; they are each of 2,383 tons, and have engines of 2,300-horse power; they are to be armed with fourteen guns each, and have been built and launched by Messrs. Elder & Co., of Glasgow. The steel hulls of these vessels are encased in teak and covered externally with copper sheathing. They have been named Carysfort, Champion, Cleopatra, Comus, and Curaçoa. Their machinery and boilers are protected by a strong armored deck. Two screw-sloops, of 1,124 tons, with engines of 900-horse power, constructed at Devonport, and named the Dragon and Pegasus. A double screw steel dispatch-vessel, of 3,573 tons, with engines of 7,000-horse power, armed with ten guns, launched at Pembroke, and named the Mercury; and a double screw iron armor-plated ship, of 7,323 tons and 6,000-horse power engines, built by Messrs. J. Elder & Co., of Glasgow, and named the Nelson, now being fitted for sea at Chatham. The new vessels ordered within the same period to be constructed, and for which the necessary preparations have been made, include a screw-corvette, steel and iron, cased with wood, of 2,383 tons, to be supplied with engines of 2,300-horse power, and to be built at Chatham Dockyard; she is to carry fourteen guns, and be named the Constance. A double screw armor-plated turret-ship, to be named the Majestic, and to be constructed at Pembroke Dockyard; a screw iron armor-plated torpedo ram, to be propelled by engines of 5,500-horse power, to be built at Chatham, and to be called the Polyphemus; four composite screw-sloops, each of 1,124 tons, and engines of 900-horse power—the Doterel, Miranda, and Phœnix, to be built at Devonport, and the Kingfisher, at Sheerness. These ships are to be half built this year and launched about next June. Two sailing brigs, building at Pembroke, to be called the Nautilus and the Pilot. The other vessels under construction include two double-screw iron armor-plated turret-ships, of 8,492 tons, designed to carry four guns each, and to be supplied with engines of 6,000-horse power. They are to be named the Agamemnon and Ajax, and are under construction at Chatham and Pembroke respectively. A screw-corvette of 2,383 tons and 2,300-horse power engines, to be armed with fourteen guns, being built of steel and iron, cased with wood (sister ship to the Carysfort, Champion, and Comus, recently launched), building at Glasgow, by Messrs. J. Elder & Co. A double-screw iron armor-plated corvette, of 4,720 tons, and to be supplied with 3,900-horse power engines, designed to carry four guns, building at Poplar, and to be christened Orion. Four double-screw iron gun-boats, of 264 tons and 168-horse power engines, each to carry one gun, to be built at Pembroke, and named Gadfly, Griper, Pincher, and Tickler; but the construction of these boats has been suspended.—*Illustrated London News.*

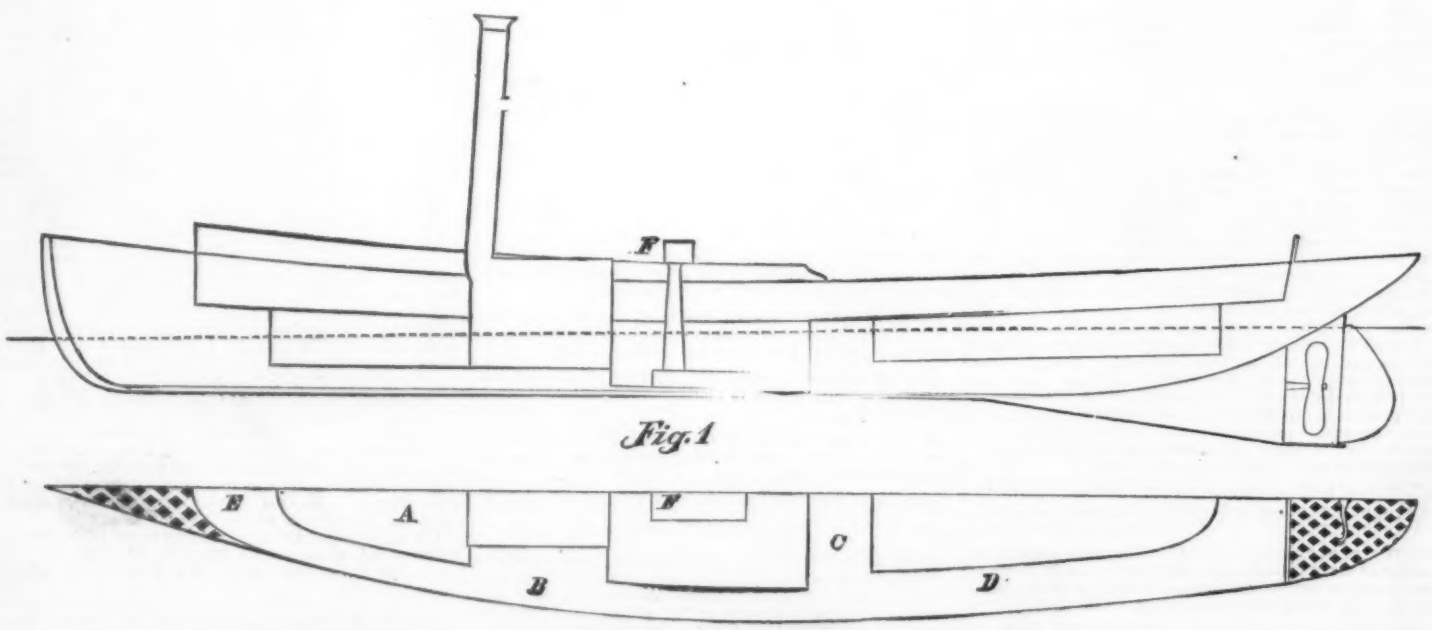
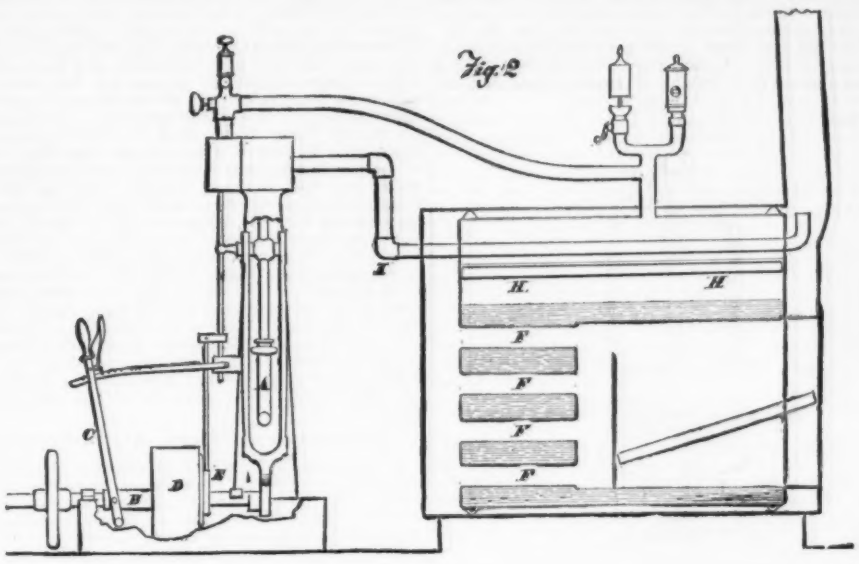
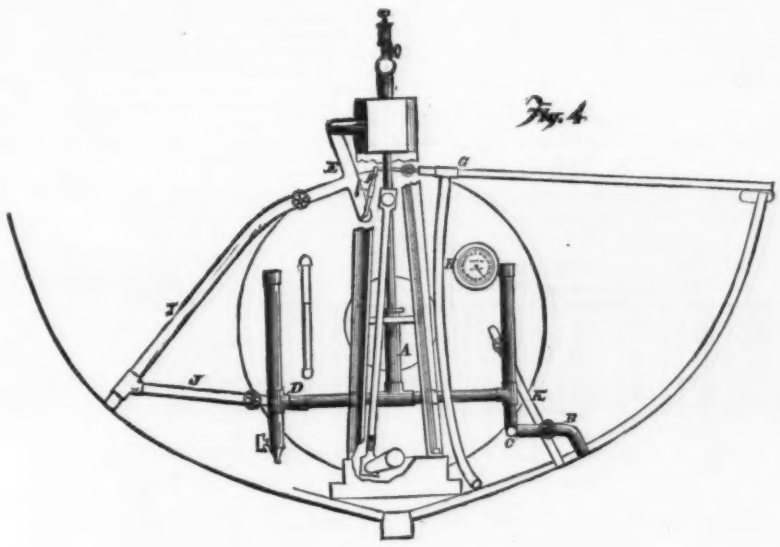
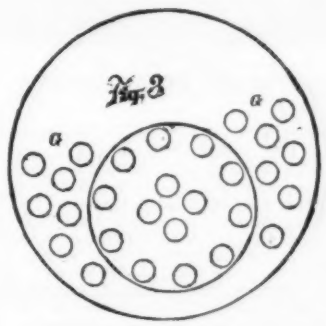



*Fig. 1*

A FAST STEAM LAUNCH.




## ENGINE AND BOILER OF MR. MAXIM'S STEAM LAUNCH.

### STEAM FOR SMALL BOATS.

THE little propeller shown in the accompanying cuts is only 21 ft. long over all, easily runs at the rate of 10 miles per hour. This boat was designed and built by Mr. H. S. Maxim.

It carries 8 or 10 persons. Her finish is most elegant and tasteful. The trimmings are black walnut, and the engine is nickel-plated throughout. An awning may be attached to the steel flag poles at bow and stern. The waterproof cushions on the seats are life-preservers. In an unoccupied corner is a force pump to supply a blast to the furnace in getting up steam. The smokepipe is provided with a spark-arrester, which may be inserted at will; in short, every convenience is provided for the comfort and pleasure of the passenger.

The dimensions of this boat are: Length over all, 21 ft.; beam, 4 ft. 2 in.; depth, 21 in.

In Fig. 1, A is the fireman's standing-room, B is a locker, C is a small fresh water tank, placed under a thwart, and under the seat at E is the pump providing the blast, and worked by a vertical lever which is removed when not used. F is the engine.

The engine is single, 3½ in. in diameter, and 3 in. stroke. The area of valve ports is 2½ in. by ¼ in. The usual cut-off is one-half. Revolutions per minute, 700.

Fig. 2 shows side view of engine and boiler. A shows the peculiar position of the pump, the piston-rod running directly into it. The reversing gear consists of a piece of tubing, B, slipping freely on the shaft. The lever, C, engages in a groove in B, thus pressing B to or fro, into or out of the drum or cylinder, D. In the drum, D, the tubing connects with a bell crank, the other arm of which throws the slotted eccentric cam, E, from one side of the shaft to the opposite. The valves may thus be completely reversed, or the eccentricity of the cam diminished any amount; hence vary the cut-off from ¾ to ¼.

The boiler is 26 in. long, and 20 in. in diameter. It is constructed of $\frac{3}{16}$ ins. steel, tested to 72,000 lbs. The boiler was tested to 450 lbs., the bursting pressure being estimated at 900 lbs. The usual pressure with light load is from 150 to 200 lbs. The furnace is cylindrical, 11 in. in diameter and 16 ins. long. The upper end of grate is about 11 in. from top of furnace. The area of grate surface is 1 sq. ft. Area of heating surface, 34 sq. ft. The flues, F F F F, are 19 in number, 1¼ in. in diameter; there are 21 return tubes, G G, Fig. 3. H H indicates a T-iron brace running the length of the boiler. This brace is perforated, and prevents foaming.

In Fig. 4, E indicates the waste pipe running through boiler to the smokepipe. When the engine is stationary, the ⅛ in. pipe, F, admits live steam into the waste pipe, to make a draught; it also discharges through pipe, G, which, by means of the flexible tube, H, clears all water from the bottom of the boat. The surface and bottom blow-offs are respectively indicated by K and J. The pump, A, receives salt water from the pipe, B. The pipe shown in cross section at C, runs aft to the fresh water tank. A steam gauge is placed at either end of boiler.

The propeller is of copper and tin, two-bladed, and 18 ins. in diameter. The pitch varies from 23 to 26 in., mean, 25 in.; and the blades are about 6 ins. wide, curving forward slightly, as in the Hirsch propeller. The draught of the yacht aft, loaded, is about 32 in.

The weight of boiler is 260 lbs.; of engine, 75 lbs. Weight of machinery complete, 400 lbs. The hull is built in the lightest manner, the frames mere oak "ribbons," the planks ½ in., and no ceiling inside. The boat is but very little heavier than the lightest rowboat of equal length, and the lines are quite as sharp. As the machinery is extremely light, the fineness of the lines is not sacrificed to an unnecessary carrying capacity, as is often the case.

The owner states that he uses salt water, and blows off one-third of all the water he uses, and is not troubled with priming. The coal used is carried in ballast bags, and employed as ballast till consumed. The stiffness of the boat is noticeable, owing to the fact that the center of gravity of the boiler stands on a level with the load waterline, and not above it, as usual.

G. F. S. gives us a description of a small steam yacht owned by Mr. H. H. Caswell, of Newport, Vt.: Length of keel, 15 ft.; length over all, 18 ft.; width of beam, 5 ft.; depth of boat, 2½ ft.; very sharp at waterline; engine is placed near stern of boat, boiler a few feet forward of it. The boiler is 18 in. diameter by 42 in. high, contains 28 lap-welded iron tubes 28 in. long; fire box, 14 by 14 in. Boiler is lagged with black walnut, bound with brass bands. The engine is also upright. Cylinder, 3¼ diameter by 6 in. stroke; connecting rod, 15 in. from center to center.

The steam supply pipe is ¾ in., and is formed into a coil of 8 or 9 turns inside of smokestack, then passes down one of the tubes to bottom of boat, and then to engine. The exhaust pipe is 1 in., passes through 5 ft. of 2-in. pipe along bottom of boat, which forms heater. By a 3-way cock the exhaust is directed through side of boat or up the stack, which is 8½ in. diameter. A steam ejector is used to clear boat from water. The screw is 20 in. in diameter, has 3 blades, and is 3 ft. pitch; shaft is 1⅛ in. diameter.

The boat is on Lake Memphremagog, which runs from Newport, Vermont, up into Canada. Boiler engine and screw, made by Shedd, of Waltham, for the owner, who fitted it into boat. He writes that he tested boiler at 200 lbs., and in running holds steam at 150 lbs.; can run the length of the lake, 31 miles, in 3½ hours, and for half an hour has run at the rate of 9½ miles an hour; for high speed uses hemlock bark for fuel; states that there are 7 boats on the lake, some of which are many times larger than his, but he can outrun all except a low pressure boat 150 ft. long.

G. H. S. sends us the following: I have a launch, built by myself, of the following dimensions: Length of hull, 33 ft.; beam, 5 ft.; fine lines fore and aft; engine cylinder, 4 in. by 6 in.; cut-off, ¾ stroke; boiler, 26 in. diameter by 4 ft. high, with 117 tubes, 1¼ in. On this boiler I can get from cold water 25 lbs. steam to sq. in. in 9 minutes. By starting my engine I get a draught that in 10 minutes more gives me 100 lbs. pressure. I use the hardest of hard Lehigh coal of a poor quality, and then have more steam than I can use, running with the door open most of the time. I have run a measured mile in 6 minutes with a four-bladed propeller, 32 in. diameter, 4 ft. pitch. With a two-bladed propeller, same size, I made the same distance a few seconds less than 5 minutes; this in still water, with steam pressure 120 lbs. The boiler does not foam or lift in the least, and the boat is as steady as I could wish.

This is a very good performance, and we hope to hear from other competitors. We have frequently recommended vertical boilers for small boats.

G. S. W. writes: My yacht, which is comparatively a new one, I purchased about two years ago with the machinery all in. Until this summer, I have used the boiler and engines as I found them. The boiler is a good one, 30 by 56 in., horizontal, with sixteen 2¼ in. and twenty-seven 1¼ in. return flues. I run this boiler to the best advantage in my power, sparing no pains or money to make it do my work, but with the most unsatisfactory results. Sometimes it would seem to take a fit, and, with a strong head wind in its favor, would do very well, provided I continually crowded it; but the least negligence on the part of my engineer, and down the steam would go, and, more than likely we could not get a pressure of more than 30 or 40 lbs. the balance of the day. Last winter I put in a patent upright and horizontal boiler combined, which I purchased at the fair of the "American Institute." This is but 36 by 36 in., with sixty-four 1¼ in. flues, taking up about half the room of the old boiler. With this boiler I have no trouble whatever to make steam very easily in half to three quarters of an hour to 30, and in a run of one mile reaching 70 to 90 lbs. I have a superheater that passes through the hood or cone of the smokestack, about 3½ by 16 in. of ¾ in. solid cast brass, which I think a great help.

I have made a run of 14 miles in an hour and ten minutes again and again with 90 to 100 lbs. pressure, and have made 12 miles an hour with 80 to 90 lbs. quite frequently, and, one day, with a large party, made 106 miles in 11 running hours. I have no trouble in running at this high rate of speed all day, if I wish. The engines are double 3¾ by 6 in. steel, and placed directly opposite each other at an angle of about 35°. The wheel is 3 flanged, 32 in., with 3 ft. pitch, the engines making from 160 to 170 revolutions. The model is perfect, and she appears to make just as rapid time with 23 to 25 passengers as with 3 or 4. The boat is 37 ft. by 6 ft. 6 in. beam.

We are glad to receive these accounts of the good performance of vertical boilers, as we have so frequently recommended them to our readers. But horizontal boilers give good results also, when properly proportioned, and we hope to hear from some yachtsmen who have this class of boiler and are satisfied with the performance of their boats.

*Twenty-five-Foot Steam Launch.*—Our correspondent F. S. sends us the following: Last spring I built a yacht, 25 ft. long, 4 ft. 9 in. beam. The frame of oak, sawn to form, 1¼ in. square, and planked with ⅝ pine, and calked. She has a boiler 3 ft. high, and 2 ft. 2 in. diameter, firebox 1 ft. 3 in. high and 1 ft. 11 in. diameter, with 49 2-in. tubes. The engine is one of S. M. Maxim's, 3 by 3 in., same as the Flirt, (after which I called mine); the wheel is three bladed, 22 in. diameter, 2 ft. 6 in. pitch. The speed attained was very good, she having made a straight run of 56 miles in six hours and a quarter. This, of course, is not a simple spurt of a mile or two, and, therefore, is a better test of her running capacity. I might also mention that our river is very much obstructed by refuse from the saw mills; in some places the cuttings and sawdust are several inches thick, and somewhat interferes with the speed as well as choking the pump; then, again, the blocks sometimes get into the wheel, as they did on the occasion mentioned, and twice brought the engine to a sudden stand, thereby straining the engine. She ran under an average pressure of 160 lbs. She was well loaded, having fuel for a journey of 160 miles, as well as 3 men on board.

*Details of a small Yacht.*—A correspondent sends the following description of a small boat built by him in the summer of 1878:

The boat is a lap streak, 26 feet long over all, and 5 feet beam; the planking is of pine. ⅝ of an inch in thickness; the ribs are of oak, ¾ of an inch thick and 1¼ inch wide, steamed and bent in, and placed 6 inches between centers. The boiler is made of steel $\frac{3}{16}$ inch thick in the shell, and the firebox and tube sheets are of iron ¼ inch thick, and is 34 inches high, 20 inches diameter, with a firebox 17 inches in diameter and 15 inches high; there are 56 inch tubes 19 inches long, the engine is vertical, with cylinder 3¼ inches diameter and 4 inches stroke, and weighs 100 lbs. The

wheel is 20 inches diameter, with 3 blades, and has a pitch of 34 inches, and is placed 3½ feet from stern post, thus giving room for the rudder forward of the wheel above the shaft; the shaft is supported by the stern pipe, which is 8 feet long and is made of 2 inch gas pipe, and extends from the stuffing box to the wheel, and has a bearing in each end. With 100 lbs. of steam the engine makes 325 revolutions per minute, and drives the boat 8 miles per hour in still water. The pump is ⅞ of an inch in diameter and 1¼ inch stroke, and gives plenty of water. The above results are taken from actual tests, and are correct in every particular.

*Small Steamboats.*—Mr. S. Firth, of Auckland, N. Z., sends the following description of the construction and performance of a small steamboat:

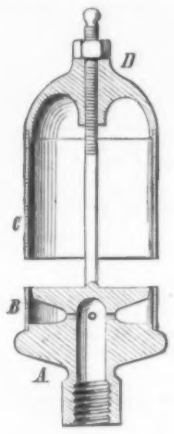
The engine was built by my brother and myself, most of it of an evening after we were home from work and on holidays. We made our own drawings and patterns, and had the casting and forgings done at the foundry.

The cylinder is 4½ inches diameter, with 5 inch stroke of piston, cutting off at ⅖ stroke; pump ⅝ inch diameter by 5 inches stroke. We usually ran her at 300 or 400 revolutions a minute with 75 lbs. steam. The boiler is horizontal, 2 feet 6 inches diameter and 3 feet long, 4 feet over all, with a 6 inch smoke box at each end; there is a flue right through the boiler, 15 inches diameter, and return tubes which are also 3 feet long, 1¾ inches outside diameter. There are 18 tubes, but the boiler would have been better if there were 6 more. The boat is wood, diagonal built, 24 feet keel, 26 feet 5 inches over all, 5 feet 8 inches beam over bead, 3 feet 9 inches deep; built with very fine lines both fore and aft.

The propeller is 2 feet diameter and 3 feet pitch. With a 4 bladed propeller, 3 feet pitch, we ran the measured mile (6,080 feet) with tide, carrying 80 lbs. steam, in ten minutes. Not being satisfied with this performance, we cut two blades off, when, with 2 bladed propeller, 3 feet pitch, we ran the same distance, with the same pressure, in slack water, in 8 minutes and 40 seconds. In this case the tide had just turned and was slightly against us.

We also tried a three bladed propeller, 2 feet diameter, 2 feet 10 inches pitch, when she ran the mile in 8 minutes and 55 seconds with the tide, carrying 75 lbs. steam. From the above it will be seen that the 2 bladed screw gave the best results.

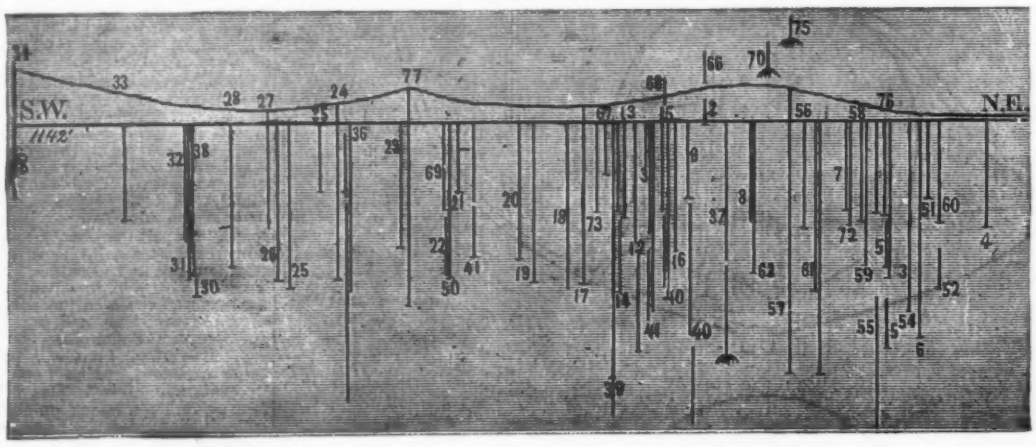
*An Easily Made Steam Whistle.*—The construction of this steam whistle will be readily understood from the accompanying engraving. The casting, A, has a stem for supporting the bell, and there is a deep groove around it forming a steam passage. A short piece, B, of brass tubing is fitted and soldered to it, leaving an annular space of about




1/100 inch between its upper edges and the casting. The bell, C, is of the same diameter as the part, B, and it has a cast head, D, which is screwed on the stem of the casting, A. The steam passages are so clearly indicated in the cut as to require no description. The proportions of the bell may be varied. By lengthening the bell the tone may be made lower.

*Steamboat Signals.*—The ordinary code of engine signals is as follows: Engine stopped, 1 stroke on gong, go ahead slow; engine stopped, 2 strokes on gong, back slowly. Engine going ahead or back slowly, jingle bell, go fast; engine going ahead or back slowly, 1 stroke on gong, stop; engine going ahead or back fast, 1 stroke on gong, slow engine. The pilot signals are: Steamers approaching head on—Each steamer must pass to the right of the other, and the pilot who first determines to turn gives one short blast of the steam whistle, which must be immediately answered by the other pilot. Two short blasts, answered by the other pilot, when first pilot considers it safer to pass to the left. Series of short blasts, in rapid succession, signifies that the pilot who makes them is in doubt as to the signals of the other pilot, and wishes to have them repeated. One long blast to be given within a half mile of a curve or bend, to be answered by the pilot of any other steamer within hearing. One long blast in a fog signifies that the steamer is under way. Three blasts in a fog signifies that the steamer is drifting or at anchor.

*Pitch.*—The pitch of a propeller is the distance it would advance in the direction of its axis at each revolution if it worked without slip. The pitch of a screw should be from 1½ to 1¾ times its diameter.




## ARTESIAN WELLS IN SAN FRANCISCO.

*Proportions of Hulls, Engines, and Boilers of Yachts.*—The following table gives dimensions of hull and machinery as proportioned by a well-known builder of steam yachts:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weights. | Weight of Engine and Boiler and all fixtures complete. | | lbs. | 1,500 | 1,700 | 2,000 | 3,000 | 4,800 | 7,500 | 8,500 | 10,000 | |
| | Weight of Engine, Wheel, Shaft, Bearings and Bolts. | | lbs. | 350 | 375 | 500 | 750 | 1,200 | 2,700 | 3,200 | 3,000 | |
| Boiler. | Heating surface. | | sq. ft | 75 | 90 | 115 | 170 | 246 | 332 | 402 | 504 | |
| | Height of shell. | | in | 28 | 30 | 33 | 36 | 46 | 50 | 54 | 60 | |
| | Diameter of shell. | | in | 45 | 46 | 48 | 56 | 76 | 82 | 86 | 90 | |
| Engine. | Size of Propeller wheel. | Pitch. | ft. | 3 | 3 | 3½ | 4 | 5 | 5 | 6 | 7 | |
| | | Dia. | in. | 26 | 28 | 30 | 36 | 42 | 48 | 54 | 56 | |
| | Size of shaft. | Length. | ft. | 12 | 13 | 15 | 16 | 18 | 25 | 30 | 35 | |
| | | Diameter. | in. | 1⅜ | 1½ | 1⅝ | 2 | 2½ | 3 | 3½ | 3½ | |
| | Size of Cylinder. | Stroke. | in. | 5 | 5 | 6 | 7 | 9 | 12 | 12 | 12 | |
| | | Diameter | in. | 3 | 3½ | 4 | 5½ | 7 | 9 | 10 | 12 | |
| | Nominal H.P. of Engine. | | | 2 | 3 | 4 | 6 | 10 | 15 | 20 | 30 | |
| Hull. | Tonnage, Carpenter's measure. | | tons | 4 | 5 | 6 | 10 | 16 | 26·5 | 37·5 | 43 | |
| | Draught. | | ft. in | 2·3 | 2·4 | 2·6 | 3·2 | 3·6 | 4·2 | 4·8 | 4·10 | |
| | Beam. | | ft. in | 5·8 | 5·10 | 6·4 | 7·6 | 9·0 | 10 | 11 | 12 | |
| | Length over all | | ft. | 25 | 26 | 32 | 38 | 50 | 60 | 68 | 75 | |

*Horse Power.*—The horse power of an engine = $\frac{(\text{Mean pressure in lbs. per sq. inch}) \times (\text{Piston speed in feet per minute}) \times (\text{Piston area in sq. ins.})}{33{,}000}$

*Care of Engines.*—When a boiler is left unused for any considerable length of time, it should be dried perfectly and the inside should be coated with oil. If this cannot be done, the boiler should be entirely filled with water. If the engine is to remain unused for some time, remove the piston and coat both it and the piston with tallow; the same for the journals. Cover all of the finished parts of the engine with a mixture of white lead and tallow.

[Continued from SUPPLEMENTS No. 156 and 151.]

### ARTESIAN WELLS.

THE sketch shows the profile of the city on a line passing through Sixteenth and Howard, and Market and First, together with the depths of some of the wells below the datum of the city leveling. No. 52 is on Beale street, between Market and Mission, 53 is on Fremont, between Howard and Folsom; 54 is near the corner of Fremont and Mission; 55 is on First, between Mission and Howard; 56 is on Second, between Howard and Folsom; 57 is on the block bounded by Market, Mission, Second, and Third; 58 is between Sutter, Bush, Montgomery, and Sansome; 59 is between Bush, Pine, Montgomery, and Kearney; 60 is between Washington, Jackson, Kearney, and Dupont; 61 is between Post, Sutter, Montgomery, and Kearney; 62 is near the corner of Dupont and O'Farrell; 66, Sacramento and Polk; 67, Van Ness avenue and Sutter; 68, Bush and Larkin; 69, Van Ness avenue and McAllister; 70, Laguna and Filbert; 72, Lombard and Gough; 73, Bryant and Fifth; 75, Polk and Broadway; 76, Market and First; 77, Folsom and Ninth. Beyond the profile the land rises, as a general thing. In front of it the land is generally lower. Wells 70, 75, and 37 strike rock. Wells 39 and immediately below 40 are the deepest, running out of the limits of the figure.

Mr. Delaney says that he can answer for 1,000 wells in the city. Another well-borer has made at least 300, and it is known that many others have bored artesian wells here. The estimated capacity of the San Francisco artesian wells, 15,000,000 gallons per day, was also taken from the *Bulletin* of the same date. It is not an unreasonable estimate, as may be seen by referring to the *Bulletin;* nevertheless it was not indorsed in our articles. It is not unlikely that much of this water is allowed to waste. The *Alta* says, in support of the suggestion that this estimate is a "grave mistake:" "That amount (15,000,000 gallons per day) would be 50 gallons for every inhabitant of the city, or enough for the entire supply, whereas four-fifths of the people depend upon the Spring Valley Water Works." This argument might lose some of its force if it were known that these four-fifths of the people who have depended upon the Spring Valley water have had, at times, mingled with the drainage of Philarcitos cañon, a taste or so of water which comes from not quite so near the surface as the origin of the Spring Valley supply is generally supposed to be. If the Spring Valley Water Company have bored artesian wells to serve in augmenting their supply to the city, an additional reason exists for confidence in the ability of the strata underneath us to yield sufficient quantities of good water. The *Alta* says: "As a general rule, in the city as in the interior, the probabilities are that the artesian auger will not find water; or, in other words, by far the greater part of the area does not contain artesian water in a sufficient quantity to be of practical value." We do not think this is sustained by the facts.

#### WHERE AN ARTESIAN WELL WILL BE SUCCESSFUL.

In attempting to form some judgment as to whether or not artesian well boring will prove successful in a given locality, the general principle on which artesian wells depend must be borne in mind. Water falling on the earth as rain or snow, or whatever, is disposed of in one of three ways: Part flows rapidly over the inclined surfaces, collecting in rills, and rivulets, and rivers; part sinks into the earth; part is evaporated. That which disappears into the earth continues its course through permeable material until it meets with some impermeable obstacle. If this obstacle be a rocky cavity the water trickles into it, filling it up until some crevice is found through which the water can continue its always downward course.

If the obstacle met with be the rocky sides of some old watercourse long covered by material washed down its sides or carried into it by other means, the water follows the rocky incline to the bottom of the old channel, and runs down this to appear at the foot of the old ravine in springs, or to meet other impassable obstacles, and collect in the reservoir furnished by the old river bed until it again finds outlet.

If the obstacle be an extended and somewhat regular stratum of impermeable material the water will run along upon it, seeking the lowest portion, and filling up the space or the porous material above the stratum until again some outlet is found. If the impermeable stratum has beneath it more porous material and below that again a similar impermeable stratum, and if the two are bent in such a way as to present their edges upwards so that the percolating water has access to the porous "filling," then the two together form a kind of U tube, which may become filled with water, the water at the bottom being subject to pressure corresponding to the height to which it has risen in filling the tube. The water so caught in porous matter between impermeable strata continues in its "tube" until some break is found, and if no extensive break is met with there is a constant tendency for the water to force its way, under the influence of the above-mentioned pressure, through the upper stratum of the tubes and to appear in springs, such as are found often in the center of valleys at considerable distances from hills. This is likely to be the case only when the water-bearing strata do not reach to a great depth. When the strata are deep they may become swollen with water, having perhaps no outlet, or an outlet at great distance from the outcrop, as, for instance, under the ocean. In the latter case the strange phenomenon of fresh-water springs in mid-ocean occurs.

Considering, then, the origin of artesian supplies, it is seen that in determining a place for boring three general questions must be noticed: The configuration of the country in the locality, the character of the material occurring in the neighborhood, and the climate.

#### CONFIGURATION OF THE COUNTRY.

In studying the configuration of the country much depends upon whether the aim is to obtain a comparatively shallow or a deep well. As a general thing the shallower well will yield a smaller supply of water than the deeper, and, very naturally, a smaller area of land need be considered, and greater attention paid to the configuration in the immediate neighborhood when a shallow well is wanted than when a deep well with a probably great and invariable supply is the aim. A sufficiently good, though incomplete, illustration of this may be found in San Francisco. The Mission hills stop short of the end of the peninsula, leaving the northern part to the sand drifts and lower hills of different formation. The Mission hills are furrowed with numberless little cañons, which, in the rainy season, collect the water and send small streams down to the lower portions of the peninsula. Now, the surest place on the

peninsula to bore an artesian well for a moderate supply only, is on the low land opposite and near to the foot of one of these little cañons. If a larger and more reliable supply of water is needed, boring had better be made not so close to the hills, but nearer the bay, in the little valleys, as Hayes valley, or between Rincon hill and Ninth street hill, or south of Ninth street hill toward the Mission. In boring these there is taken into consideration the configuration of greater area than in the previous case. When still greater supply is sought for, and boring is carried into the rock underneath the city, then our petty hills no longer enter the problem, but the dip and condition of strata that may extend eastward under the coast range and outcrop in the Sierras, demand attention. Another illustration may be drawn from a part of California where few artesian wells have been bored. In parts of Tulare valley the country is covered with low, sandstone hills. These hills are parts of what was once a continuous deposit of strata, covering these portions of the valley, and, where not horizontal, rising gently toward the mountains to the east. The hills were formed by the washing away of parts of this deposit, in some places the washing having been carried so far as to lay bare the granite underlying the sandstone. The sandstone is of the tertiary age, and, under favorable circumstances, artesian wells would be expected to prove successful in it, especially as it shows a gentle decline from the mountains. Now, as in the former illustration, in choosing a place to bore a shallow well for a moderate supply, the low hills, the little valleys which they form, and the little cañons on their slopes, would be considered; while in prospecting on a large scale, the hills would be in part ignored and the broad deposits extending all over the country and rising toward the mountains, would require the larger share of notice.

#### SHALLOW WELLS.

With regard to the selection of a place to bore a shallow well, for a moderate supply, enough has perhaps been said. At the foot of cañons and in the lower parts of small valleys the boring may be made with most confidence. An almost sure indication that a well will be successful is the occurrence of springs in the neighborhood.

#### DEEP WELLS.

David Dale Owen, in the report of a geological reconnoissance of Arkansas, made in '59 and '60, gives three conditions, which are necessary to the successful boring of artesian wells: First, the fountain-head must be higher than the boring; second, there must be a general dip of the surface from the fountain-head toward the well; third, there must be alternation of porous and impervious strata. These are all self-evident. The first two illustrate well the popular idea of the best place for boring wells. A valley is *par excellence* the ideal location for a well. But "valley" need not imply the neighborhood of hills. On the contrary, the vaster the tracts of low land, and the more widely separated the hills which form the "valley," so long as the necessary conditions of strata are fulfilled, the better chance for a deep well to obtain a large and lasting supply. No hills need be in sight, and their absence should not discourage the water prospector. The larger the circumference of the rim surrounding any valley, the greater, other things being equal, the surface exposed for the catchment of water.

The most favorable condition of strata, as to inclination, is found where they dip on all sides from the rim to the center, forming a basin. They may dip towards an axis, forming a trough. Again, they may dip in but one direction, forming a nearly plane incline, in which case there can be little choice as to location of the borings.

Not only the dip of the strata demands attention, but the condition of their outcrop is also of great importance. English engineers distinguish three or four different kinds of outcrop of water-bearing strata. The porous strata that absorb the water may appear on the surface at the top of a hill, the most unfavorable occurrence. They may outcrop on the slope of the hill, and become so worn to conform to the general inclination of the hill, that the water running over their edges may have so great a velocity that only a small percentage can be absorbed. This will vary with the slope. At the foot of a hill, and in a depression, is the most favorable occurrence of the outcrop. The outcrop may be naked, so that the water may be directly absorbed, or it may be covered by drift material; in this case the character of the drift determines the amount of water that may reach the porous strata.

Besides the inclination of the water-bearing strata, and the condition of their outcrop, their regularity and continuity must be looked after. Often a bed of clay beneath a porous stratum is found to thicken up to such an extent that it is impossible for water to find a passage. An upthrust of any impervious material through the water-bearing strata may blast all hopes for artesian water in an otherwise favorable location. In such cases the land lying between the fountain-head and the barrier is the more likely to yield artesian water, as in some instances may be indicated by the appearance of springs, which indeed may be the only evidence of the existence of the barriers.

All these details of the configuration of the country may be studied with advantage before attempting to bore wells in an untried region, especially when it is intended to make that outlay which is necessary in sinking to great depths.

In our next we will take up the subjects of the "Character of Material" and the "Climate," giving illustrations relating to the position and condition of water-bearing strata and their outcrop. We shall also consider the outfit necessary for boring wells, and the *cost*.

#### WELLS BORED AND IN PROGRESS.

F. W. Morse of Chico, Butte county, obtained for us the data of a well bored on I. R. Bennett's farm, four miles north of Chico. Since the memorandum was handed to him it has been published in the Chico *Enterprise*. The well was finished one year ago, and proved a failure, reaching a depth of 686 feet without finding artesian water. The data are as follows: soil, 16 ft.; gravel, 10 ft.; yellow clay, 164 ft.; gravel, 6; earth the color of ashes, 10; cemented gravel, 3; sandstone, 20; ash-colored earth mixed with white streaks resembling burnt or slaked lime, 40; brown hard-pan, 231; quicksand, 2; very hard basalt rock, 20; soft stone resembling blue clay when pulverized, 80; quicksand, 1; sandstone, 30; pipe clay, 10; cemented gravel, 3; sand, 10; quartz gravel, 2; blue clay, 10; washed sand, 18; total, 686 ft. The bottom of the pipe is now in sand and gravel. We sunk the pipe five feet the last half day that we worked.

This is the only artesian well that has been sunk in the neighborhood. Plenty of water is obtained from surface wells at a depth of 20 ft., and in many cases a good supply is found at 6 or 8 ft. The strata are often different at places only 20 or 30 ft. apart. The water-bearing strata are principally sand and gravel.

J. W. A. W. writes us that there are only four flowing wells in Tulare county: one near Tipton, of which so much has lately been published, and three others. This well struck water at 280 ft. below 6 ft. of sandstone. It went 30 ft. deeper through clay and four gravel beds, each of which gave water. It yields 86,000 gallons of water, containing only six grains of solid matter to the gallon. The three other wells in the county are on John Heinlan's place near Lemoore. There is a good deal of pipe being made at present in San Francisco for wells near Bakersfield. Pipe is also being shipped to the San Joaquin valley and to Mendocino county.

W. G. A. writes us from Gold Hill, Nevada: At Battle Mountain, Lander county, on the line of the Central Pacific railroad, there are several artesian wells. The water is cool and quite free from deleterious chemical substances. The borings are about 150 ft. in depth, and the geological strata are mainly volcanic detritus: clay strata, gravel and suballuvium.

At Elko, on a bluff or second bank of the Humboldt, the citizens are now boring for water. They have good machinery and are confident of success. At present the auger has reached the depth of over 400 ft. The valley of the Humboldt at that point is covered by strata of gravel, sand, clay, and drusy carbonate of lime. The first artesian well in Nevada was bored in 1870, on the farm of S. C. Nevers, near Carson. Said well was 18½ ft. deep, and the stream shot out 7½ ft. above the surface, and is flowing yet with unabated vigor, sending up a stream sufficient to supply all demands for household purposes, and a surplus equal to the wants of a large number of acres for irrigating purposes.

Prof. W. F. Stewart, State Senator from Storey county, introduced a joint resolution in the Senate of the last Nevada Legislature, which passed the Senate but failed in the House, memorializing Congress to make liberal donations of land in the arid valleys of this State to parties who were successful in causing a flow of water to the surface. There are millions of acres of as fine soil as can be found in any portion of the world, covered with luscious, succulent grasses during the spring and forepart of the summer, and not a hoof of stock to eat it because there is no water. These valleys are surrounded by mountains serrated by deep cañons, which, if dammed at proper intervals, a supply might be stored up for summer use. This is one of Prof. Stewart's plans to make inhabitable the heavy rich valleys in this State that are now worthless.

The new City Hall well at San Francisco, near No. 20 in the figure, was, at last accounts, 58 ft. deep. It passed through yellow sand 40 ft., then black sand. At about 40 ft. a bed of vegetable matter was bored through. Wood of a dicotyledonous tree was brought up, together with a fibrous substance, either bark or peat.

*(To be Continued.)*

## ROTARY CONDENSER AND FEED WATER HEATER.

IT is well known that the power really available for work, furnished by steam boilers and engines as at present constructed, remains far behind the theoretical effect as calculated from the enormous quantity of fuel consumed, sometimes not even amounting to 8 per cent. This is due, besides incomplete combustion of the fuel and other causes, to the loss of heat incurred by the escaping heating gases of combustion and steam. To the many devices designed to overcome this evil, Mr. D. Martin, of Nuremberg, Germany, has added another in the shape of a novel condenser, which, if all that is claimed for it proves to be true, will indeed allow considerable saving in fuel.

The condenser may be placed into the boiler, but it is preferable to locate it in a reservoir, through which the feedwater passes before entering the boiler proper, and which may be heated by the heated gases escaping from the fire. A paddle wheel revolves on a horizontal shaft laid transversely through the reservoir, resting with one end in a journal provided on the inner wall of the reservoir, while the other extends through the opposite wall, and is on the outside provided with a pulley, which by a belt may be

Fig. 1.

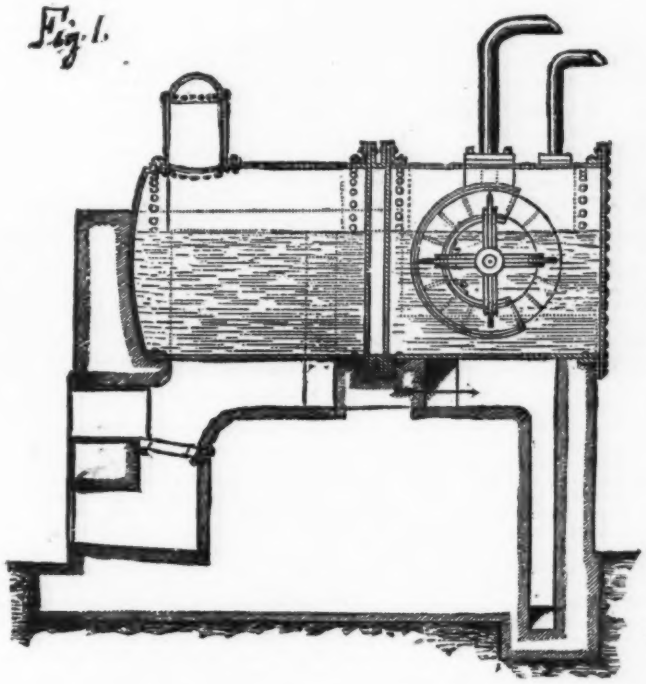
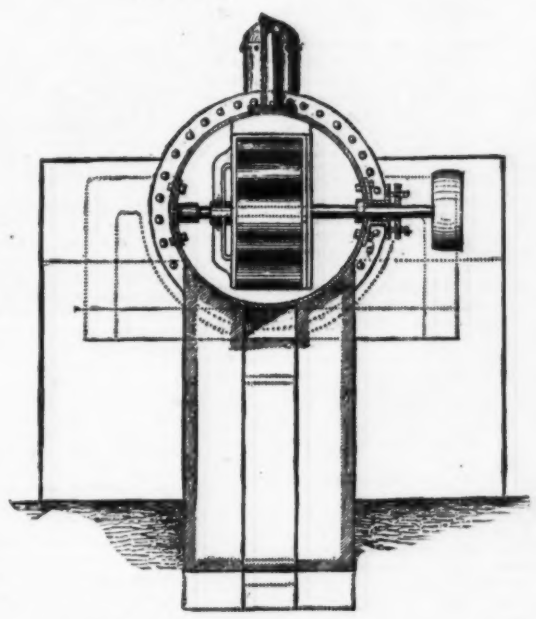


Fig. 2



## NEW BOILER FEED WATER.

connected with the engine (Fig. 2). A cast iron shell incases (steam and water tight) two thirds of the circumference of the wheel to a depth of nearly half of its radius, as shown in Fig. 1. The wheel turns toward the left so as to enter the incasing at the upper extremity, the level of the water always being kept a short distance below the same. The exhaust steam is conducted by a tube into the shell of the condenser, where it is taken up by the paddles and forced down into the coolest water at the lowest part of the condenser. It is of course immediately condensed, its heat being communicated to the water. The velocity of the wheel must be regulated, so that the cells formed by the paddles within the shell correspond in volume to the quantity of steam escaping from the engine, so as to avoid a reaction on the piston. To avoid superheating of the water of condensation or a possible pressure in the condenser, a second tube, provided with a stopcock, allows a removal of steam. The size of the condenser varies with the size of the boiler, and the other dimensions with the quantity of steam to be condensed. The wheel may be made of cast iron. The inventor's claims as regards the advantages derived from this condenser we will shortly sum up as follows:

"The pressure exerted by the exhaust steam on the piston is reduced, as the steam is partly removed by aspiration. The area of heating surface may be decreased. The disadvantage of feeding boilers with water of low temperature, so important in tubular boilers, is prevented. Impurities, which otherwise deposit in the boiler and cause incrustation, are separated in the condenser, from which they, by reason of its easy accessibility and independence from the boiler, may at any time be removed, without stopping the engine. Thus a clean, pure feedwater is secured. The heating gases are completely utilized. The condenser is adapted to all styles of boiler, and does not increase the consumption of water. It may also be easily attached to all boilers now in use. Steam is rapidly generated. An equal quantity of

steam is produced, but of a higher pressure than formerly. The construction is very simple and durable, as the wear and tear does not amount to anything, and repairs are hardly ever necessary. The saving in the cost of fuel will more than compensate for the cost of the condenser."

The value of this apparatus can, of course, only be determined by actual experience and careful comparison of the results with the effects produced otherwise. We take our illustration from *Der Maschinenconstructeur*.

## PERUVIAN ANTIQUITIES.

By E. R. HEATH, M.D., Wyandotte, Kansas.

ON the Peruvian coast in ancient times, as now, nearly every structure was made of adobes or sun dried brick, while in the mountains stone was used instead. The adobe ruins present nothing of beauty, architecturally. The subject for wonder is their immensity and number. Go where you will, relics of the past meet your eye either in ruined walls, water courses, terraces, or extensive lands covered with the debris of pottery.

### REMARKABLE RUINS AND WALLS.

Take, for example, the Jequetepeque valley. In 7° 24' south latitude you will find on recent maps the port of Pacasmayo. Four miles north, separated from it by a barren waste, the river Jequetepeque empties into the sea. The bottom lands of the river are from two to three miles in width, with a southern sloping bank, and the northern a perpendicular one nearly eighty feet high. Beside the southern shore, as it empties into the sea, is an elevated plat one-fourth of a mile square and forty feet high, all of adobes. A wall fifty feet wide connects it with another a few hundred yards east and south that is 150 feet high, 200 feet across the top, and 500 at the base, nearly square. This latter was built in sections of rooms ten feet square at the base, six feet at the top, and about eight feet high. These rooms were afterward filled with adobes, then plastered on the outside with mud and washed in colors. All of this same class of mounds—temples to worship the sun, or fortresses, as they may be—have on the north side an incline for an entrance or means of access. Treasure seekers have cut into this one about half way, and it is said $150,000 worth of gold and silver ornaments were found. In the sand, banked up behind the wall and mound, many were buried, as the thousands of skulls and bones now exposed prove, thrown out by the hunter of huacos, as the pottery is called, huaca being the name given to these cemeteries. Each body has buried with it a vessel or water craft and a pot with grains of corn or wheat, and it is supposed the drinking vessel was filled with "chicha," a fermented drink made from corn or peanuts. Beside these were many ornaments of gold, silver, copper, coral and shell beads, and cloths.

On the north side of the river, on the top of the bluff, are the extensive ruins of a walled city, two miles wide by six long. Within the inclosure are the relics of two large reservoirs for fresh water. The clay from which these adobes were made was found at least six miles distant.

Follow the river to the mountains. All along you pass ruin after ruin and huaca after huaca. At Tolon, a town at the base of the mountains, the valley is crossed by walls of boulders and cobble stones, ten, eight, and six feet high, one foot to eighteen inches wide at the top and two to three feet at the base, inclosing ruins of a city one-fourth of a mile wide and more than a mile long. The upper wall has projecting parts at the entrances, with port-holes, evidently serving as sentry boxes.

At this point the Pacasmayo Railroad enters the Jequetepeque valley. For eight miles back it crosses a barren sand plain of more than fifteen miles in length, covered with ruined walls, water courses, dead algaroba and espino trees, with fragments of pottery and sea shells even to nine feet in depth, mixed with the sand. The base of the mountains have, in good state of preservation, many thousand feet of an old water course, while their sides to the perpendicular parts are lined with terraces. This water course took its head from a ravine now dry, and, even beyond the memory of the oldest inhabitant, except in one or two cases, never carried water. It can be traced as far as Ascope, forty-five miles south.

Five miles from Tolon, up the river, there is an isolated boulder of granite, four and six feet in its diameters, covered with hieroglyphics. Fourteen miles further, a point of mountain at the junction of two ravines is covered to a height of more than fifty feet with the same class of hieroglyphics: birds, fishes, snakes, cats, monkeys, men, sun, moon, and many odd and now unintelligible forms. The rock on which these are cut is a silicated sandstone, and many of the lines are an eighth of an inch deep. In one large stone there are three holes, twenty to thirty inches deep, six inches in diameter at the orifice and two at the apex, and although polished as porcelain, these markings extend even to the bottom. The locality is of no importance; the stones as nature placed them; why, then, was so much labor and time expended upon them?

At Anchi, on the Rimac river, upon the face of a perpendicular wall two hundred feet above the river bed, there are two hieroglyphics, representing an imperfect B and a perfect D. In a crevice below them, near the river, were found buried twenty-five thousand dollars worth of gold and silver. When the Incas learned of the murder of their chief, what did they do with the gold they were bringing for his ransom? Rumor says they buried it, and many places are pointed out and thousands of dollars spent in useless search for the lost treasure. May not these markings at Yonan tell something, since they are on the road and near to the Incal city?

Eleven miles beyond Yonan, on a ridge of mountains seven hundred feet above the river, are the walls of a city of 2,000 inhabitants. A perilous ascent on hands and knees is now the only way to reach it; however, on the opposite side of the river are similar ruins, but easy of access. A remnant of a stone wall, ten and twelve feet high, built of small flat stones and without mortar, probably at one time served as river protection and against the tribe on the other side, there being a tradition that two powerful chiefs occupied these cities and were ever at war. The dead were buried in sepulchers, using large boulders as the top, while stone walls divided the space beneath into compartments. Six and twelve miles further are extensive walls and terraces. Three miles north of the latter place are the rich silver mines of Chilete, formerly worked by the Indians, who left excavations two and three hundred feet deep, and must have taken out quantities of silver. A company with a paid-up capital of half a million is now working them.

### PIZARRO'S PRISON.

Leaving the valley at seventy-eight miles from the coast, you zigzag up the mountain side 7,000 feet, then descend 2,000, to arrive at Cajamarca, or Coxamalca of Pizarro's time. Here and there all the way you find relics of the past. In a yard off one of the main streets, and near the center of the city, is still standing the house made famous as the prison of Atahualpa, and which he promised to fill with gold as high as he could reach in exchange for his liberty. Like all their stone work, the walls are slightly inclined inward, uncemented, built of irregular stones, each exactly faced to fit the next. The floor and porch are cut out of the solid stone, two and three feet deep, as the still intact remnants of stone pillars of the same rock show. The hill from which the stone for the walls was taken is near by. On its top a large stone in the shape of a chair bears the name of "Inca's chair," and the Indians say it was the king's custom to sit here every morning and salute the sun as it rose above the horizon. The two large places excavated out of the rock on the hillside, and now used as reservoirs for the city, were of ancient make.

Three miles distant, and across the valley, are the hot springs, where the Inca was encamped when Pizarro took possession of Cajamarca. Part of the wall is of unknown make (that incloses the baths). Cemented, the cement is harder than the stone itself.

At Chocofan, nine miles from Pacasmayo, on the line of the railroad, a barren, rocky mountain, 1,200 feet high, is encircled four hundred feet from its top by a stone wall eight or ten feet high. From its northern side, running nearly northwest, is about five miles of the coast road of the Incas. Perfectly straight, it is twenty feet wide, and walled on both sides by round stones piled to a height of three and four feet, three feet wide at the base and two at the top, uncemented.

At Chepen, a station near the terminus of the branch of the Pacasmayo Railroad, is a mountain with a wall in many places twenty feet high, the summit being almost entirely artificial. In the sand at its base is one of Peru's most extensive "huacas," and from which some of the finest pottery and ornaments have been taken.

### THE WONDERFUL HUACAS.

Fifty miles south of Pacasmayo, between the seaport of Huanchaco and Truxillo, nine miles distant, are the ruins of "Chan Chan," the capital city of the Chimoa kingdom, which extended, when conquered by the Incas, from Supe to Tumbez, or over nearly the northern half of the coast of modern Peru. The road from the port to the city crosses these ruins, entering by a causeway about four feet from the ground, and leading from one great mass of ruins to another; beneath this is a tunnel. Be they forts, castles, palaces, or burial mounds called "huacas," all bear the name "huaca." Hours of wandering on horseback among these ruins give only a confused idea of them, nor can old explorers there point out what were palaces and what were not.

To the right is the "Huaca of Toledo;" to the left, "Bishop's Huaca." The large square inclosures, shut in by wedge-shaped walls of adobe, twenty to twenty-five feet high, have nothing of an entrance into them that would be defined as a palace gate. A half dozen of these at least are among the ruins. Within some of them are large square mounds or burying chambers, many of which have been opened and rifled of their contents. These are plastered at the ceilings.

Beside the so-called "huacas" already mentioned, there is another on the left side of the road, called by the Spaniards "the Mass." On many of the walls is some excellent stucco work—excellent as regards the material of which it is made, more than with reference to its style of art. There is not a single grain of disintegration in the parts that surround the walls of the chamber, although it is half an inch high above the ordinary plaster in which it is done, nor the slightest impairment in its integrity during the many centuries it has stood exposed to the elements. The highest inclosures—those of adobe brick, up to thirty feet, with a base of fifteen feet, on the right hand of the city as you advance toward Truxillo, between that town and the "Toledo huaca"—must have cost an immense amount of labor, and needed a large number of hands for their erection. Inside some of them, besides the square mounds, are narrow passages, not more than a yard in width. In others are squares, wherein are visible, though now filled with clay, the outlines of water tracks. On this side are the principal burial mounds, some having stairs of adobe.

### THE GOLD ACCOUNTS OF TRUXILLO.

In the city of Truxillo there exists in the records of the municipality a copy of the accounts that are found in the book of Fifths of the Treasury, in the years 1577 and 1578, referring to the "Huaca of Toledo." The following is a condensed inventory:

FIRST.—In Truxillo, Peru, on the 23d of July, 1577, Don Garcia Gutierrez de Toledo presented himself at the royal treasury to give into the royal chest a fifth. He brought a bar of gold, nineteen carats ley, and weighing two thousand four hundred Spanish dollars, of which the fifth, being seven hundred and eight dollars, together with one and a half per cent. to the chief assayer, were deposited in the royal box.

SECOND.—On the 12th of December he presented himself with five bars of gold, fifteen and nineteen carats ley, weighing eight thousand nine hundred and eighteen dollars.

THIRD.—On the 7th of January, 1578, he came with his fifth of large bars and gold, one hundred and fifteen in number, fifteen to twenty carats ley, weighing one hundred and fifty-three thousand two hundred and eighty dollars.

FOURTH.—On the 8th of March he brought sixteen bars of gold, fourteen to twenty-one carats ley, weighing twenty-one thousand one hundred and eighteen dollars.

FIFTH.—On the 5th of April he brought different ornaments of gold, being little bells of gold and patterns of corn-heads and other things, of fourteen carats ley, weighing six thousand two hundred and seventy-two dollars.

SIXTH.—On the 20th of April he brought three small bars of gold, twenty carats ley, weighing four thousand one hundred and seventy dollars.

SEVENTH.—On the 12th of July he came with forty-seven bars, fourteen to twenty-one carats ley, weighing seventy-seven thousand three hundred and twelve dollars.

EIGHTH.—On the same day he came back with another portion of gold, and ornaments of corn-heads and pieces of effigies of animals, weighing four thousand seven hundred and four dollars.

The sum of these eight bringings amounted to 278,174 gold dollars or Spanish ounces. Multiplied by sixteen, gives $4,450,784 silver dollars. Deducting the royal fifth, $985,-953.75, left $3,464,830.25 as Toledo's portion.

Even after this great haul, effigies of different animals, of gold, were found from time to time. Mantles also, adorned with square pieces of gold, as well as robes made with feathers of divers colors, were dug up. There is a tradition that in the huaca of Toledo there were two treasures, known as the great and little fish. The smaller only has been found.

Between Huacho and Supe, the latter being one hundred and twenty miles north of Callao, near a point called Atahuanqui, there are two enormous mounds, resembling the Campana and San Miguel of the Huatica valley, soon to be described.

About five miles from Patavilca (south and near Supe) is a place called "Paramonga," or the fortress. The ruins of a fortress of great extent are here visible; the walls are of tempered clay, about six feet thick. The principal building stood on an eminence, but the walls were continued to the foot of it, like regular circumvallations, the ascent winding round the hill like a labyrinth, having many angles, which probably served as outworks to defend the place. In this neighborhood much treasure has been excavated, all of which must have been concealed by the pre-historic Indian, as we have no evidence of the Incas ever having occupied this part of Peru after they had subdued it.

### IMMENSE BURYING GROUNDS.

From Lima north along the coast the Ancon and Chancay Railroad is built. Ancon, eighteen miles from Lima, is a favorite summer seaside resort. Just before reaching Ancon, the railroad runs through an immense burying ground or "huaca." Make a circuit of six to eight miles, and on every side you see skulls, legs, arms, and the whole skeleton of the human body lying about in the sand. Legs attached to pelvis, and bent up, still with mummified skin on them; arms in the same state; relics of plaited straw, forming coffin swathes; pieces of net, of cloth, and many other such accompaniments of funeral accessories.

Some water crafts of very superior quality have been obtained from these graves. Of these there are three different forms in places separated a short distance from each other, but each style having its defined outline of *locale*. As to the shape of the graves, there are some of an inverted cylinder form, like that of a lime-kiln, the insides of which are lined with masonry work. In these the body is placed in the upright position. There is also the ordinary longitudinal grave, in which the corpse is right in contact with the earth; likewise the grave cut square to a depth of six to eight feet, at the top of which; or within one or two feet of the surface of the ground, is a roofing or covering of mat work, placed on wooden rafters. In one of these Dr. Hutchinson, Her Britannic Majesty's Consul at Callao, found three bodies, all wrapped up together—being a man, woman, and child—their faces being swathed with llama wool instead of cotton, as is usually seen in ordinary ones. He also turned out relics of fishing nets, with some needles for making them, varieties of cloth, tapestry, and work-bags resembling ladies' reticules. Not a vestige of vegetation about, nor sign of relic of the terraces mentioned by Prescott. Whence came these hundreds and thousands of people who are buried at Ancon? How did they make out a living while on the earth? Time and time again the archæologist finds himself face to face with such questions, to which he can only shrug his shoulders and say with the natives, "Quien Sabe?" Who knows?

At Passamayo, fourteen miles further "down north," and on the sea shore, is another great burying ground. Thousands of skeletons lie about, thrown out by the treasure seekers. It has more than a half mile of cutting through it for the Ancon and Chancay Railroad. It extends up the face of the hill from the sea shore to the height of about 800 feet, and being from a half to three-fourths of a mile in breadth, some idea may be formed of its extent.

Dr. Hutchinson, in two days, from these burial grounds, gathered 384 skulls, which, with specimens of pottery, he presented to Professor Agassiz, and he to the Cambridge University, near Boston.

Between the teeth he found pieces of copper, as if for the Charon obulus, and one or two had plates of copper on their heads.

Crossing the brow of the hill, entering Chancay, and stretching toward the sea, are the remains of a six feet adobe wall. On the face of this hill, pointing to the line of the railway from Ancon, are two stone ditches, perfectly parallel and symmetrical, about 100 yards apart, and running from bottom to top to a height of about 300 yards. Between these are other lines of stone displaced, perhaps the ruins of some old terraces. All about this place, at the base of the hill, looking toward Chancay, as well as on the side in front of the sea, is full of graves; some are built up with stone walls, others, lined inside with mud bricks, of no formation more than a heap of clay and water moulded up in the hands and dried in the sun. Over the hills of Chancay are quantities of small stones of different geological formation from the rock there.

Lima, the capital of Peru, is situated seven miles inland from Callao. Nine miles on the sea shore "up south," is the city of Chorillos, the Long Branch of Peru. A railway connects Lima with these two cities, forming with the coast nearly a right-angled triangle. This triangular ground is known as the Huatica Valley, and is an extensive ruin. Between Callao and Magdalena, four miles distant, there are seventeen mounds called "huacas," although they present more the form of fortresses, residences, or castles, than burying grounds. 'Tis difficult to make out anything but fragments of walls, as the ground is mostly under cultivation. However, at various points, one can see that a triple wall surrounded the ancient city. These walls are respectively one yard, two yards, and three yards in thickness, being in some parts of their relics from fifteen to twenty feet high. To the east of these is the enormous mound called Huaca of Pando; and to the west, with the distance of about half a mile intervening, are the great ruins of fortresses, which natives entitle Huaca of the Bell. La Campana, the huacas of Pando, consisting of a series of large and small mounds, and extending over a stretch of ground incalculable without being measured, form a colossal accumulation. The principal large ones are three in number; that holding the name of the "Bell" is calculated to be 108 to 110 feet in height. At the western side, looking towards Callao, there is a square plateau with an elevation of about twenty-two to twenty-four feet, 95 to 96 yards north and south, east and west. At the summit it is 276 to 278 yards long, and 95 to 96 across. On the top there are eight gradations of declivity, each from one to two yards lower than its neighbor; counting in direction fengthwise, the 1st plateau is 96 to 97 yards; 2d plateau, 96 to 26 yards; 3d plateau, 23 to 24 yards; 4th plateau, 11 to 12 yards; 5th plateau, 11 to 25 yards; 6th plateau, 23 to 24 yards; 7th plateau, 35 to 36 yards; 8th plateau, 35 to 37 yards; making the total of about 278 yards. For these measurements of the Huatica ruins I am indebted to the notes of J. B. Steere, Professor of Natural History and Curator of the Museum at Ann Arbor, Michigan.

*(To be Continued.)*